Missouri Stream Team

Volunteer Water Quality Monitoring Program

Summary of Data: 1993-2016

Acknowledgements

The Missouri Stream Team Program would like to thank Stream Teams United for their role in the creation of this report. We appreciate Dan Obrecht and Tony Thorpe's expertise in compiling and analyzing the Stream Team volunteer water quality data and summarizing it for this report. Their hard work has resulted in a publication that truly showcases volunteer efforts while describing water quality across the state. We would also like to thank the Stream Team staff at the Missouri Department of Conservation and Missouri Department of Natural Resources for reviewing and contributing to the final report.

Finally, we cannot extend enough appreciation to the Stream Team volunteers who have dedicated their time and talents to monitoring our state's streams and playing an active role in protecting our state's water resources.

This project was funded by the Missouri Department of Natural Resources.

Missouri Stream Team staff – back row (left to right): Randy Sarver (former staff member), Molly Runyon, Amy Meier, Karen Westin, Chris Riggert, and Jenna Stiek; front row (left to right): Lily Kennedy, April Sevy, Sherry Fischer, and Kat Lackman.

Cover: ST 4325, Roark Creek, Taney County

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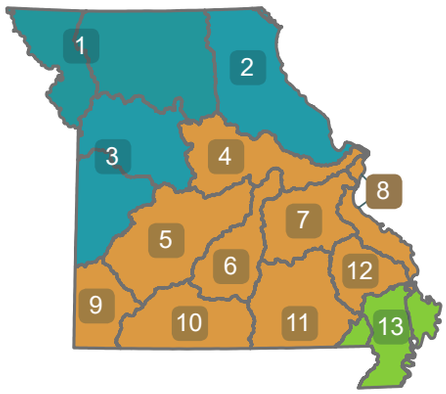


This map shows the 3 major Missouri Ecoregions: Plains (blue); Ozarks (orange); and Mississippi Alluvial Basin (green). Numbers represent the regional divisions used in this report.

ST 5080, Bonhomme Creek, St. Louis County

Introduction

Missouri Stream Team staff started filling a new filing cabinet 25 years ago. Week by week they have added folders containing data sent in by trained volunteers from all corners of the state. Those volunteers tested streams as shallow as bath mats and as deep as their waders. They did it to understand and document the condition of Missouri streams – with the hope of aiding in their protection. Their combined effort comprises the Missouri Stream Team Volunteer Water Quality Monitoring program (VWQM), which in 2018 marks a quarter century of dedicated data collection — a milestone we think is worth celebrating.

This report summarizes individual reports gathered between 1993 through 2016. It is meant to provide feedback to volunteers and educate Missouri citizens.

Every spring and fall, volunteers receive training in proper monitoring techniques at VWQM workshops held statewide. They learn four monitoring protocols, two of which directly measure water quality condition: invertebrate sampling and water chemistry monitoring. In this report we describe why aquatic invertebrates (e.g. larval insects, crustaceans, mussels, etc.) make such good indicators of water quality condition. We also describe the chemistry parameters volunteers measure, including how they impact water quality and

ST 31, Blue Springs Creek, Crawford County

ST 4628, Little Blue River, Jackson County

what the potential causes for concerning levels of different parameters are. This information will help readers interpret the summarized volunteer water quality data that make up the bulk of the report.

A method for data analysis was designed to accommodate both the natural variability of water quality conditions and the variability in the numbers of VWQM measurements taken at a given site. A presentation of the data assessment method used, and the value of long-term data collection, will also help in interpretation of the data summary. We use Missouri's natural ecoregions and watershed boundaries to develop meaningful regions for describing water quality conditions. On the regional pages, we also graph average VWQM data results across the regions for each measurement type to allow a statewide comparison of each parameter.

We hope this report shows Stream Team volunteers, and others, what VWQM data can tell us about water quality in Missouri. After 25 years of monitoring, our filing systems and data analysis have evolved into the digital era, but some things haven't changed: we remain sincerely grateful for each report we receive from our hard-working volunteers!

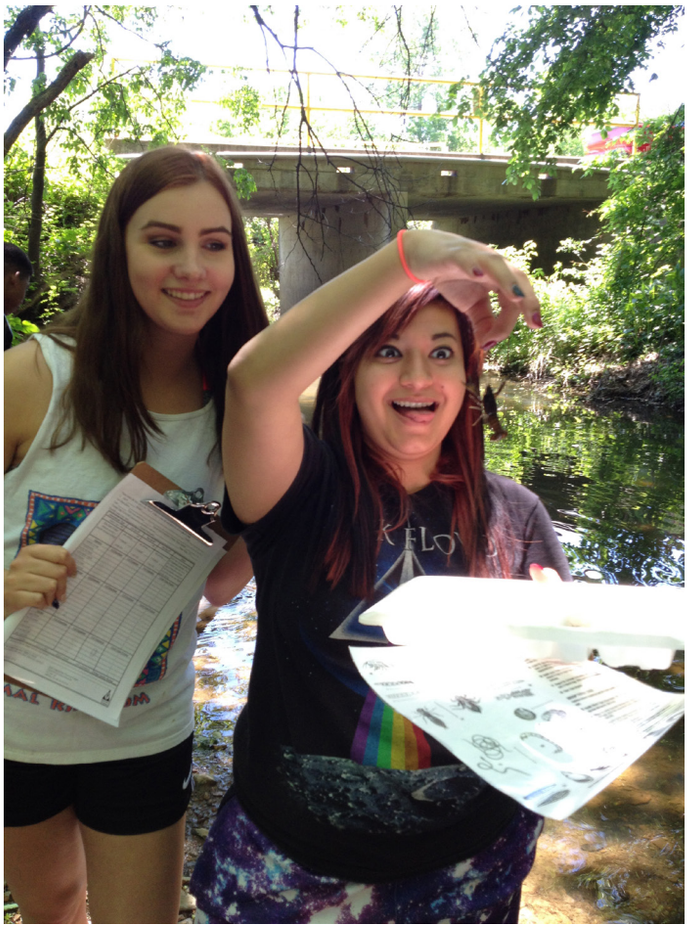
Invertebrate Monitoring to Gauge Stream Health

One of the challenges in monitoring water quality in streams and rivers is that conditions within waterways change frequently. Short-term pollution events can occur and have a negative effect on aquatic life, but may go unidentified by water sampling unless the sample collection is timed perfectly. Chronic pollution may remain at concentrations low enough to go unnoticed, yet may still negatively impact aquatic life. There are also changes in habitat (e.g. sedimentation, channelization), the impacts of which are difficult to measure. Monitoring invertebrates allows us to overcome some of these challenges by providing a way to gauge water quality over time at a given site, taking into account both current and past water quality levels.

What makes this possible are the facts that many invertebrates have life cycles that last a year or more, and they are relatively immobile. Tied to the same small section of stream, they are unable to escape if water quality becomes impaired. If a pollution event eliminates sensitive invertebrates from a stream, a delay would be expected before the lost species return to the stream. If a stream or river is affected by a chronic pollution issue, we would expect the aquatic community to be constantly disturbed.

The most important reason monitoring a stream's invertebrates is a good way to gauge stream health is that they have differing tolerances to pollution, which allows us to use them as biological indicators of water quality levels. Some types of invertebrates are capable of living in streams with poor water quality, while others can only survive in the cleanest of water.

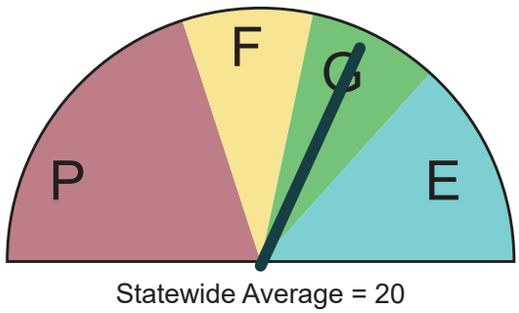
Volunteer monitors are trained to identify 24 types of aquatic invertebrates that fit into three categories of pollution tolerance: Sensitive, Somewhat Tolerant, and Tolerant. By identifying the numbers and types of invertebrates present, volunteers can assign a score to the stream. A water quality rank is then derived from the score (see table below). Streams with a high diversity of invertebrates, including many Sensitive organisms, will have a higher score than those with a low diversity of invertebrates and a majority of Tolerant species.



ST 2800, Pearl River, Pettis County

Score	Rank
>23	Excellent
18-23	Good
12-17	Fair
<12	Poor

Invertebrate scores and subsequent water quality rank



Statewide Average = 20

Water Chemistry Monitoring Parameters

Pieces of the Water Quality Puzzle

There are many ways to measure the health of a stream.

Along with invertebrate monitoring, which measures stream health based on the invertebrate population, many volunteers also take physical and chemical measurements which can indicate why a stream site is unhealthy. While the parameters monitored may seem quite different, in many ways they are interrelated, just like puzzle pieces. When evaluated together they can provide us with a thorough assessment of water quality conditions.

Dissolved oxygen (DO) is a measure of the oxygen available in the water for aquatic life. Sources of oxygen include the air we breathe (mixed into the water by diffusion or through tumbling action and turbulent flow) and the oxygen produced by algae and aquatic plants during photosynthesis. If DO levels are too low, fish and invertebrates may be stressed or even killed. Low levels may occur either naturally during summer low flow conditions or when pollutants enter the stream. Excess nutrient concentrations may cause an unnatural increase in biological productivity in the stream (including excessive algal growth) that creates a high demand for oxygen which can cause DO levels to plummet. High ammonia levels may cause decreased DO through chemical transformation. Conditions that increase water temperature can also diminish available DO because the warmer water is, the less DO it can hold.

Nitrate and ammonia are two forms of nitrogen found in streams and rivers. While nitrogen is a nutrient required by aquatic life, it acts as a fertilizer and promotes excess algal growth at elevated concentrations. Ammonia is a reduced form of nitrogen that will use up dissolved oxygen as it chemically changes form. Ammonia can also be toxic to aquatic life; its toxicity is dependent on both temperature and pH. Sources of nitrate and ammonia include effluent from wastewater treatment plants, poorly functioning septic systems, runoff from feedlots, and excess fertilizer applied to lawns and croplands.

ST 5268, Tributary to Lake Jacomo, Jackson County

Phosphate, like nitrogen, is a nutrient required by aquatic life that acts as a fertilizer in aquatic systems. It occurs at much lower concentrations than nitrogen and is often the nutrient that limits the growth of algae and aquatic plants. The problem associated with excess phosphate is the same as high nitrogen levels: excessive algal growth. Sources of phosphate are generally the same as the sources of nitrogen, with one notable difference: phosphate binds to soil particles more readily than nitrogen. Runoff with high levels of sediment entering a stream or river will likely have elevated phosphate.

Turbidity is a measure of water clarity and is determined by the amount of suspended materials in the water. These suspended materials might be inorganic, like soil particles, or organic matter, like algae. Not only can high turbidity reduce a stream's aesthetic appeal, it can also negatively affect aquatic life. High levels of suspended materials may result in sedimentation that fills in the interstitial spaces in the stream substrate, reducing habitat for invertebrates and negatively affecting fish reproduction. Turbidity caused by soil materials happens when stream bank erosion and runoff from disturbed areas, such as developments and plowed fields, carry soil into the stream.

pH is a measure of the concentration of hydrogen ions (H+) relative to hydroxide ions (OH-), measured on a scale from 0 (acidic) to 14 (basic). If there are equal concentrations of hydrogen and hydroxide ions, then the pH is 7 and the water is considered neutral. If hydrogen ions outnumber hydroxide ions, then the water is acidic and the pH will be less than 7. Most aquatic life requires a specific range of pH for good health. Increases or decreases in pH levels can stress or even kill invertebrates and fish. A particular negative impact from acidic pH levels is that they can cause toxic heavy metals to be released from sediment and become available for uptake by aquatic life. Human influences that may decrease pH are generally associated with air pollution that causes acid rain.

ST 432, Railey Creek, Stone County


ST 3184, North Fork Salt River, Shelby County

Conductivity is a measure of the ability of water to conduct an electric current. In simple terms, it is dependent on the amount and types of dissolved materials (specifically ions) in the water. Because water is a great solvent, it readily picks up ions as it flows over and through rocks and soil, thus a stream's conductivity often reflects the geology and land use of the stream's watershed. High conductivity may not be toxic to aquatic life, but it may indicate the presence of pollution. Both nonpoint sources of pollution, such as urban or agricultural runoff containing road salt, fertilizer, or animal waste, and point sources, such as effluent from wastewater treatment plants, can elevate conductivity readings above natural levels.

Chloride is one of the most common ions in Missouri's streams and rivers, mainly as a result of human activity. Under natural conditions, chloride is found in low concentrations relative to other ions such as calcium or magnesium. Chloride can be toxic to aquatic life both at high levels for a short period of time (acute toxicity >860 mg/L) and at lower levels over a longer time period (chronic toxicity >230 mg/L). Human influences that can increase chloride include ice-melting road salt and effluent from sewage treatment plants (humans have a high salt diet so our wastewater is high in sodium chloride).

The Value of Long-term Data Collection

Long-term data, collected consistently at the same site, are the most valuable for determining stream health.

Water chemistry in streams is quite variable over time. It can be different in rainy conditions versus dry, on sunny days versus cloudy, with high flow versus low, in riffles versus pools, early in the morning versus late afternoon, etc.

Similarly, aquatic invertebrate sampling counts at a given site can be highly variable. One reason is the naturally patchy distribution of invertebrates within the stream. Another source of variation in the data is the seasonality of the invertebrate community. Many of the invertebrates are larval insects, and will fly away from the stream as they emerge as adults after their final molt. Their absence from a single sample does not mean they are absent from the stream.

These factors, and many more, can impact the water chemistry measured and the invertebrates collected in a stream. Except in extreme cases, measures of a stream's health can only be teased out of the natural, inherent variability through multiple data collections over an extended period of time.

To account for this, we had to carefully examine the extensive VWQM data set and focus on those sites with several monitoring visits over several years. Using only data from those sites, we arrived at a single average value for each measure of water quality for a given site.

Invertebrate data: Only sites with monitoring events in at least four years were considered for analysis. In order to address the natural seasonality of invertebrate population counts, at sites where multiple samples were collected within a year, only the maximum annual value was used (as opposed to the annual average). The maximum scores for each year were then used to calculate each site's average invertebrate score.

Chemistry data: Sites with at least five sampling events across at least three years were selected for analysis; then average values were determined for each parameter at a given site. Data not meeting these criteria were set aside until additional Stream Team monitoring can be conducted.

Assessed Sites By Region

The number of sites with sufficient data for assessment varied greatly from region to region. For invertebrates, the number of sites assessed ranged from one in Region 13 to 63 sites in Region 10. Water chemistry data showed similar variations. Dissolved oxygen was the most monitored parameter and ranged from one site with enough data for assessment, again in Region 13, to 94 assessed sites in Region 7. This uneven geographical distribution is also reflected in the overall volume of data in the VWQM data set. The uneven distribution of sample sites across the state occurs because volunteers select the sites they want to monitor, which tend to be located close to home. This explains why rural areas tend to be under-represented relative to urban areas where the population is higher. Within each regional write-up you will find a table that provides the number of sites assessed for each parameter. Please note, that the lower the number of sites assessed for a given parameter, the less likely it is that the data represent water quality for the whole region.

ST 3099, Dry Sac River, Greene County

Data Assessment – What does the Data Tell Us?

Once sites with sufficient invertebrate data for assessment were selected, average scores were assessed using the system familiar to volunteer monitors: invertebrate scores were evaluated against a ranking system where ranges of values determine what water quality category the score indicates (see chart on page 3).

Once sites with sufficient water chemistry data for assessment were selected, their data needed to be evaluated to determine if levels of a given parameter at a given site appeared healthy or indicated potential water quality degradation. To do this, a meaningful set of criteria needed to be employed to compare the volunteer data to: these criteria are thresholds beyond which we might expect water quality to be negatively impacted.

The set of screening criteria used for this report are the same that are used when Stream Team VWQM staff screen the volunteer data to look for potential areas of concern. Stream sites that regularly exceed these screening criteria are flagged for follow up monitoring by agency staff or as part of a CSI monitoring project (see page 36).

What makes these criteria meaningful is that, for many of the parameters measured, they are based on the State of Missouri's Water Quality Standards (WQS).

Stream Team volunteers collect data on water chemistry measures that affect the ability of aquatic life to survive and thrive. Missouri has Water Quality Standards written into our Code of State Regulations (10 CSR 20-7.031) which provide protections for the designated uses (Aquatic Life, Swimming, Fishing, Drinking Water, etc.) of Missouri's waterways. Some of the parameters that volunteers measure have WQS for at least some uses (DO, pH, Ammonia, Chloride, and Nitrate [Drinking Water only]), and the rest do not. A single parameter may have different WQS levels for different uses. Generally we see effects to aquatic life before effects to the other uses.

As part of the follow up process for sites flagged as having potential water quality concerns, agency staff or CSI projects may conduct more rigorous and frequent monitoring using U.S. Environmental Protection Agency approved methods to better characterize the problem. This monitoring must be of sufficient quality and rigor to meet Clean Water Act requirements as well as provide a statistically sound assessment of the stream. If this additional assessment constitutes a violation of Missouri's WQS then it will be listed in Missouri's 305(b) Report and 303(d) List.

The goal of the federal Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Preparation of the 305(b) Report and 303(d) List is mandated by Sections 303(d) and 305(b) of the Clean Water Act requiring that each state identify waters not meeting water quality standards and for which adequate water pollution controls have not been implemented. The Missouri 305(b) Integrated Report provides an overview of the status of Missouri's waters. The report summarizes water quality issues and judges the degree of progress Missouri has made toward meeting federal Clean Water Act goals. The 305(b) report also includes the list of impaired waters that are on the 303(d) List.

Screening Criteria

The table below shows screening criteria levels for water quality parameters monitored by Stream Team volunteers. DO, pH, and chloride are the same as Missouri's WQS. The other parameters have levels that if they are observed long term above these levels they may start to have an effect on the stream if the sources are not remedied.

Parameter	Screening Criteria Level
Dissolved Oxygen	Less than 5 mg/L
pH	Less than 6.5
Nitrate	2.0 mg/L or greater
Ammonia	1.0 mg/L or greater
Phosphate	3.0 mg/L or greater
Chloride	230 mg/L or greater
Conductivity	1600 µS/cm or greater
Turbidity	No screening value
Invertebrates	No screening value

Missouri's Ecoregions

In order to compare natural properties across the state, Missouri's landscape is often divided into large areas based on the topography, soils, geology, etc. At perhaps the largest statewide scale are three broad ecoregions: Plains, Ozarks, and Mississippi Alluvial Basin.

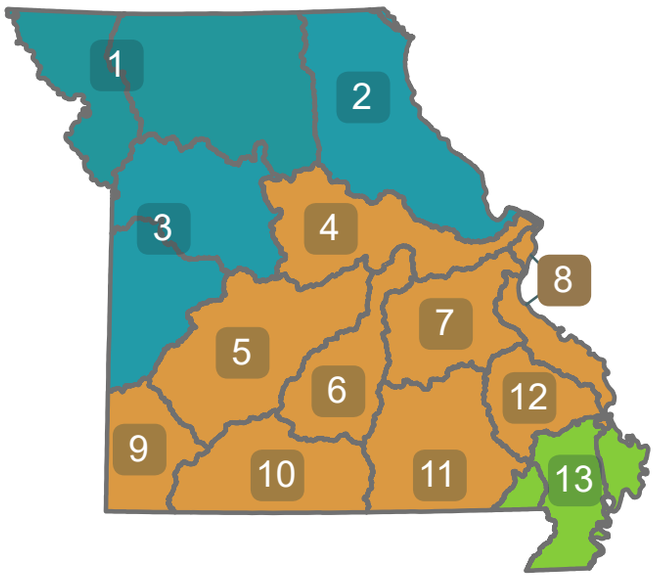
The Plains ecoregion to the north (Glacial Plains) and west (Osage Plains) has deep, rich soils that make this region ideal for growing crops. Groundwater is deep and often saline. The landscape is largely rolling hills with limited patches of forest.

To the south lies the Ozarks ecoregion. Compared to the Plains, this ecoregion has steeper hills and is more frequently forested. Groundwater is abundant compared to the Plains. The soil tends to be thin and rocky, better suited for pasture land than growing crops.

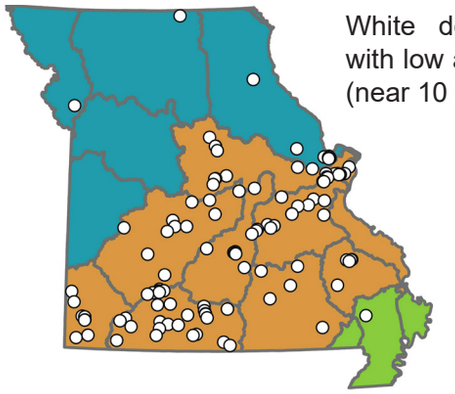
In Missouri's bootheel is the Mississippi Alluvial Basin ecoregion. This low, level land has been wiped flat by the meandering of the Mississippi River, which subsequently deposited rich, fertile soil in its floodplain. The streams in this region are now predominately ditches, used to drain water from the abundant crop land.

Because of these differences, water chemistry and invertebrate communities vary naturally across the state. Invertebrates that require cool water and rocky substrate may be less abundant in the Plains regions, while those that prefer to burrow in soft substrate might be more abundant. Measures of water chemistry that reflect the influence of groundwater, such as nitrate (which is readily carried in groundwater), may be naturally higher in the Ozarks. Of course, there will be exceptions. Forested streams exist in the Plains, as do streams that run through deep soils in the Ozarks.

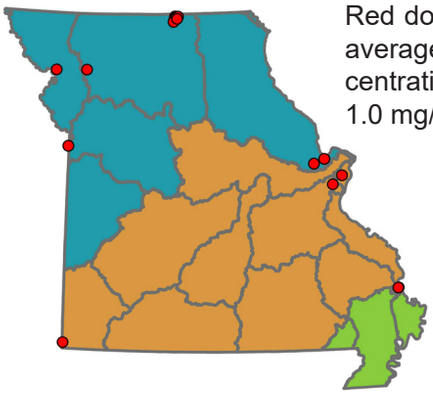
Ecoregional differences become apparent when viewing the data on a statewide scale. A comparison of values across the regions can help us understand how water chemistry differs between the Plains and the Ozarks (only 2 sites were assessed in the Mississippi Alluvial Basin). Some of the parameters, like dissolved oxygen and pH, differ little between the two ecoregions. Turbidity, however, is considerably lower in the Ozarks than the Plains. The nutrients phosphate and ammonia show similar statewide trends, though not as clearly as turbidity. See maps at right.



This map shows the 3 major Missouri Ecoregions: Plains (blue); Ozarks (orange); and Mississippi Alluvial Basin (green). Numbers represent the regional divisions used in this report.



White dots show sites with low average turbidity (near 10 NTU).



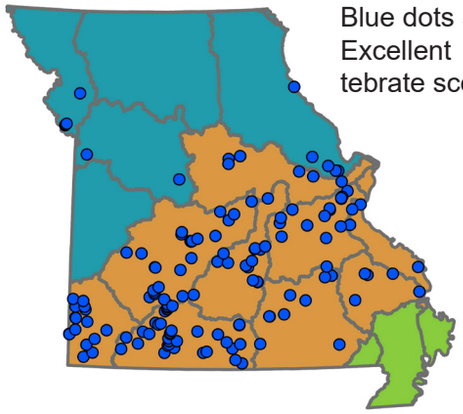
Red dots show sites with average ammonia concentrations greater than 1.0 mg/L.

The bar graph on the right shows the percentage of sites with Excellent, Good, and Fair/Poor (combined) water quality based on invertebrate scores. Regional differences are apparent, as most Ozark sites are either Excellent or Good, while the Plains sites are mostly Good and Fair/Poor. These regional differences in assessed water quality probably reflect a combination of actual differences in water quality, variations in habitat, and the fact that the Stream Team scoring system is probably better suited for the Ozarks than the Plains. The map to the right shows sites with Excellent invertebrate scores, and is another illustration of this point.

This bar graph shows the percentage of sites within the Plains and Ozarks ecoregions that fall into 3 invertebrate score categories.

Further Regional Divisions

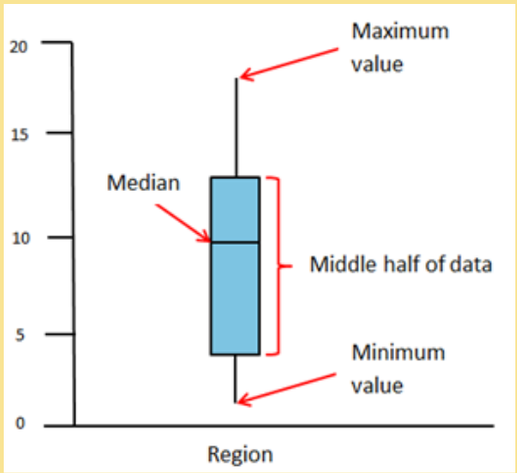
For this report, since aquatic organisms and available habitat can differ between watersheds, we further subdivided the larger ecoregions (Plains and Ozarks) into ecological drainage units (EDUs), delineated by the watersheds of rivers. To maximize the number of sites for our analyses, we combined some of these drainage units to form our regions. Regions were numbered for reference, and are referred to on the Regional pages by their EDU names (this is different from the previous VWQM data summary reports). See the map on the top of the opposite page for the regional divisions used in this report. Maps on the regional pages show each region's rivers, streams, and assessed site locations (shown as white dots).



Blue dots show sites with Excellent average invertebrate scores.

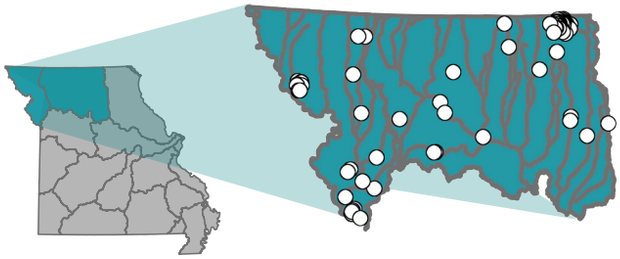
How to Read the Box Plots

Throughout the report, you will see box plots (i.e. "box-and-whisker" plots) comparing a specific water quality parameter across the regions of the state. These box plots show the range of values (y-axis) within each region (x-axis) for comparison. The values used are averages of an individual monitoring site's data. Each region's "box" encloses the middle half of the data's range, while the "whiskers" (vertical lines extending from the box) indicate the range out to the minimum and maximum average site values. The horizontal line within the box represents the median, which is the value at the middle of the data set's range – where half of the values are above, and half are below. The median is used to describe the middle of the data because, unlike the mean (i.e. average), it is not influenced by extreme minimum and maximum values.



Region 1 - Nishnabotna, Platte, Grand, & Chariton Rivers

Plains Ecoregion



River drainages in Region 1 include the Nishnabotna, Nodaway, Platte, Grand, Thompson, Chariton, and Long Branch rivers. This region is one of the largest in area and includes northwest and north-central Missouri. The western portion of this region is heavily agricultural, transitioning to a mix of agriculture, pasture/grassland with small patches of forest to the east. Urban areas in this region include St. Joseph and northern Kansas City.

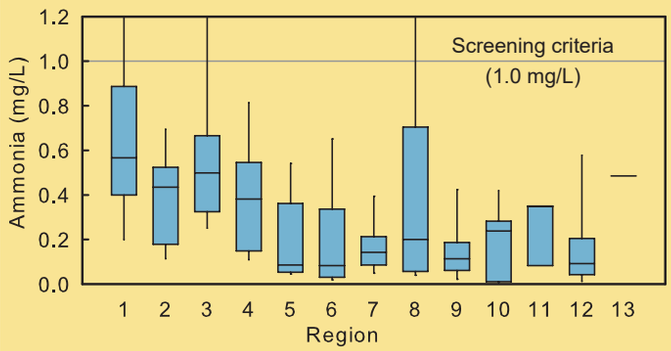
Values for the nutrient nitrogen were a concern in Region 1, with 17% of sites exceeding the screening criteria for nitrate (2 mg/L) and 20% exceeding for ammonia (1 mg/L). There were as many sites exceeding the ammonia screening criteria in this region as in the rest of the state combined, primarily in Putnam County, near Unionville.

Twenty sites (30% of sites in the region) had average turbidity values greater than 40 NTU, and half of those were greater than 70 NTU. While there is no screening value for turbidity, these high values indicate an abundance of particulate matter, likely soil, in the water.

Water quality in Region 1, based on the invertebrate data, was the best of the Plains regions, with an overall average score of 19 (Good). There were nearly twice as many Excellent and Good ranked sites (14) as there were Fair and Poor (8).

ST 3949, Prairie Creek, Platte County

A Statewide Look at: Ammonia



This plot shows the range of ammonia concentrations (vertical axis) at assessed sites by region (see page 9 for how to read a box plot).

Ammonia values were generally higher in the Plains (Regions 1-3) than elsewhere in Missouri, with the exception of Regions 4 and 8 which both have a substantial number of urban sites.

Region 1 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	1923	1967	1875	1419	1284	104	1822	1619
Assessed Sites	78	79	77	61	45	3	74	65
Median (Assessed Sites)	9.2	7.7	0.75	0.57	0.35	38	457	31.1
Average (Assessed Sites)	9.2	7.8	1.68	0.78	1.11	71	481	40.5

Chemistry Summary

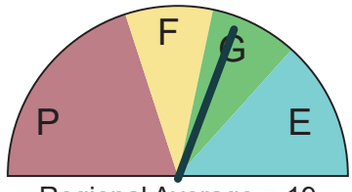
Reference values listed are screening criteria indicating values of potential concern.

- **DO**: Only 1 assessed site (out of 78) had an average value of concern (less than 5 mg/L)
- **pH**: Only 1 assessed site (out of 79) had an average value of concern (6.3)
- **Nitrate**: 13 of the 77 assessed sites (17%) had average values over 2.0 mg/L
- **Ammonia**: 12 of the 61 assessed sites (20%) had average values over 1.0 mg/L
- **Phosphate**: Only 1 assessed site (out of 45) had an average value over 3.0 mg/L
- **Chloride**: 9 of the 104 total regional chloride measurements exceeded 230 mg/L; maximum average value for 3 assessed sites was 196 mg/L
- **Conductivity**: The maximum average value for 74 assessed sites was 1207 µS/cm, well below the screening criterion (1600 µS/cm)
- **Turbidity:** 10 of the 65 assessed sites (15%) had average values above 70 NTU

Invertebrate Summary

- There were 22 sites assessed on 14 streams, 5 with multiple sites
- Average scores for assessed sites range from 9 to 28, with a regional average of 19
- 3 of the 4 sites with Excellent scores are on Brush Creek, Platte County

Invertebrate Rank	# of Sites
Excellent	4
Good	10
Fair	6
Poor	2
Total	22

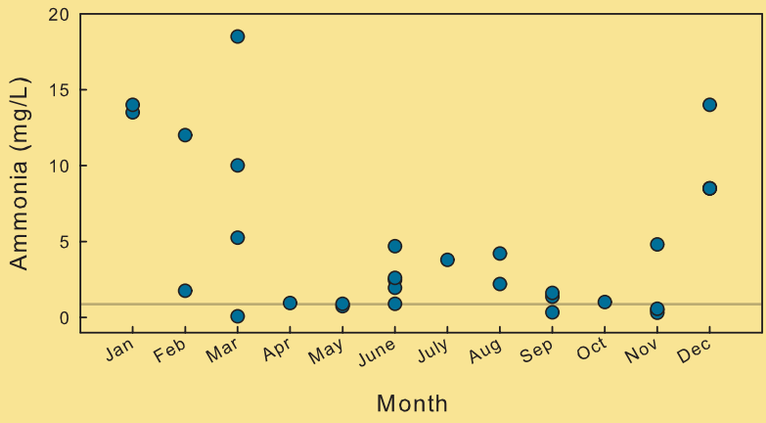


Regional Average = 19


ST 700, Rush Creek, Platte County

Ammonia in Region 1

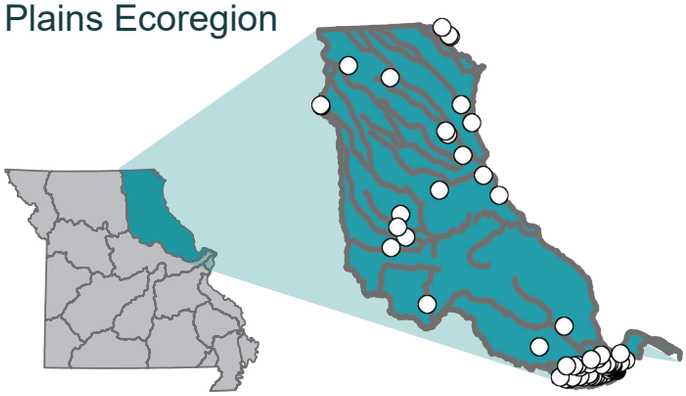
Ammonia concentrations (vertical axis) were measured in all twelve months (horizontal axis) over a four year period in South Blackbird Creek. The graph shows that the highest values were measured during winter months (Dec. to March), when terrestrial vegetation is generally dormant and not making use of the ammonia in the watershed. Note, values exceeding the screening criteria of 1.0 mg/L (horizontal line) occurred in 8 different months.




Grand River
Davies County

Region 2 - Cuivre & Salt Rivers

Plains Ecoregion



ST 463, Dardenne Creek, St. Charles County

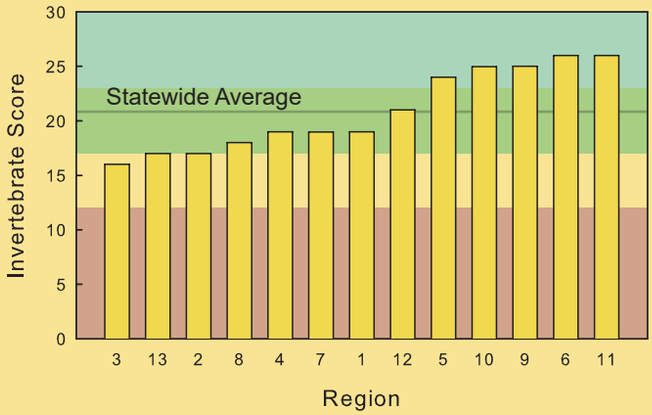
Larger rivers in Region 2 include the Salt, Fabius, Wyaconda, and Cuivre. This region encompasses the northeast portion of the state and extends as far south as the St. Charles area outside of St. Louis. Land use is varied in the region, with agriculture and grass/pastureland dominating, but with many of the assessed sites in the southern part of the region having substantial urban/suburban influences. Rivers in most of this region drain eastward into the Mississippi River, though some in the southern portion of the region empty into the Missouri River.

The average values at three sites (all in St. Charles County) exceeded the screening criteria for nitrate, ammonia, and phosphate. Two sites had average dissolved oxygen values greater than 12 mg/L, which might suggest excess algal growth.

Turbidity levels were high (>40 NTU) in about a quarter of the assessed sites (13 of 55), with three sites averaging more than 70 NTU. There is no screening value for turbidity, but high values indicate an abundance of particulate matter, likely soil or algae, in the water.

Invertebrate scores were on the low end compared to the other regions, with an overall regional average of 17 (Fair). More sites scored Fair or Poor (20) than Excellent or Good (18).

A Statewide Look at: Invertebrate Scores



In this graph the overall average regional invertebrate scores (vertical axis) are ordered from lowest to highest (horizontal axis).

Regions with the lowest averages tended to be either northern plains regions or those regions with a substantial number of sites in urban areas. Ozark regions in southern Missouri tended to have the highest overall scores. Only a single site was assessed in Region 13.

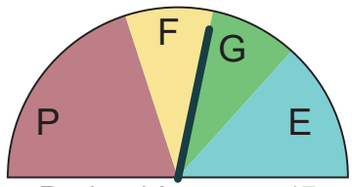
Region 2 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	1903	1896	1699	1104	1145	316	1609	1489
Assessed Sites	66	65	58	47	41	23	60	55
Median (Assessed Sites)	9.0	7.9	0.40	0.44	0.85	29	512	22.3
Average (Assessed Sites)	9.2	7.8	0.86	0.45	1.05	37	541	28.7

Chemistry Summary

Reference values listed are screening criteria indicating values of potential concern.

- **DO**: 15 of the 66 assessed sites (23%) had a very healthy average value of 10.0 mg/L or more; none of the sites had an average value of concern (less than 5 mg/L)
- **pH**: All 65 assessed sites had an average value between 7.2 and 8.2; none of the sites had an average value of concern (less than 6.5)
- **Nitrate**: 3 of the 58 assessed sites (5%) had average values over 2.0 mg/L
- **Ammonia:** 3 of the 47 assessed sites (6%) had average values over 1.0 mg/L
- **Phosphate**: 3 of the 41 assessed sites (7%) had average values over 3.0 mg/L
- **Chloride**: All 23 assessed sites had average values of 134 mg/L or lower, well below the screening criterion (230 mg/L)
- **Conductivity**: All 60 assessed sites had average values below 1000 µS/cm, well below the screening criterion (1600 µS/cm)
- **Turbidity**: 10 of the 55 assessed sites (18%) had average values between 40 and 70 NTU, with 3 sites (5%) averaging more than 70 NTU

Invertebrate Rank	# of Sites
Excellent	5
Good	13
Fair	16
Poor	4
Total	38



Regional Average = 17

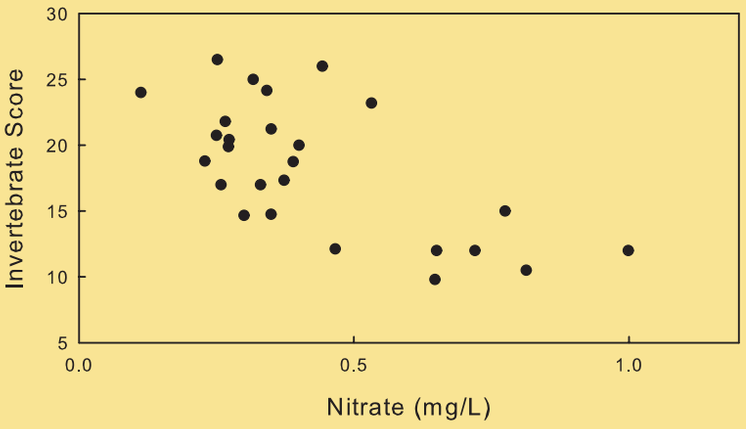

ST 463, Dardenne Creek, St. Charles County

Invertebrate Summary

- There were 38 sites on 18 different streams assessed in this region
- Average scores for assessed sites range from 8 to 26, with a regional average of 17
- All 4 sites with Poor water quality scores are in urban areas of St. Charles County and 3 are located on Spencer Creek

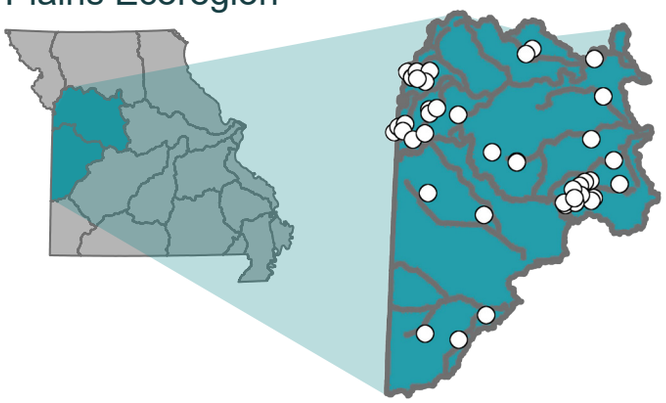
Invertebrate Scores vs. Nitrate in Region 2

For the 26 assessed sites in Region 2 with both nitrate and invertebrate data, we compared the average invertebrate score (vertical axis) to the average nitrate value (horizontal axis). Sites which average more than 0.5 mg/L nitrate tend to have lower invertebrate scores (10 to 15), while sites with lower nitrate have higher scores (15 to 27). This does not necessarily mean that the nitrate is the cause of the lower invertebrate scores.



Region 3 - Blackwater, Lamine, Osage, & South Grand Rivers

Plains Ecoregion



ST 4628, Little Blue River, Jackson County

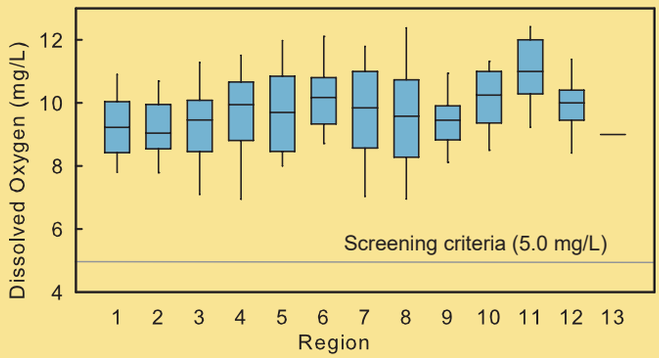
Region 3 combines the greater Kansas City Area with the western portion of the Osage Plains. The northern portion of this region includes the Blackwater River, Little Blue River, Lamine River and a portion of the Missouri River. To the south are the South Grand River and the Osage River. Land cover is mostly urban in the Kansas City area, a combination of grassland and agriculture to the south, and mostly agricultural along the Missouri River floodplain.

Screening criteria were exceeded at four sites for nitrate, three sites for ammonia, and one site each for phosphate and chloride. These exceedances represent 7-20% of the sites evaluated for the parameters.

Six of 28 assessed sites (21%) had average turbidity values that exceeded 40 NTU, with two sites exceeding 70 NTU.

This region had an average invertebrate score of 17, and was one of only three regions that did not score Good or Excellent according to the Stream Team scoring system. Fourteen sites scored Excellent or Good and the remaining 12 scored Fair or Poor.

A Statewide Look at: Dissolved Oxygen



This box plot shows the dissolved oxygen concentration at assessed sites in all 13 regions (see page 9 for how to read a box plot).

Regions 1-3, located in the Plains, tended to have slightly lower dissolved oxygen levels than most of the other regions. The top of the box extends to around 10 mg/L in the Plains, a value that is closer to the median (horizontal line within the box) for many of the Ozark regions.

Region 3 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	695	689	615	426	147	67	658	423
Assessed Sites	44	42	42	27	14	5	43	28
Median (Assessed Sites)	9.4	7.9	0.58	0.50	0.38	66	480	24.4
Average (Assessed Sites)	9.3	7.8	1.50	0.69	0.68	138	505	31.5

Chemistry Summary

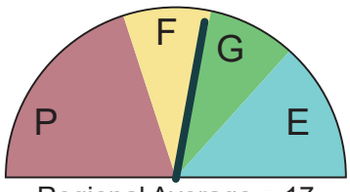
Reference values listed are screening criteria indicating values of potential concern.

- **DO**: 15 of the 44 assessed sites (34%) had a very healthy average value of 10.0 mg/L or more; none of the sites had an average value of concern (less than 5 mg/L)
- **pH**: Average values at all 42 assessed sites appear normal
- **Nitrate**: 4 assessed sites (out of 42) had an average value over 2.0 mg/L
- **Ammonia**: 3 of the 27 assessed sites (11%) had average values over 1.0 mg/L
- **Phosphate**: Only 1 of the 14 assessed sites (7%) had an average value over 3.0 mg/L
- **Chloride**: 1 of the 5 assessed sites (20%) averaged more than 230 mg/L
- **Conductivity**: Average values at all 43 assessed sites were well below 1600 µS/cm
- **Turbidity**: 6 of the 28 assessed sites (21%) had average values over 40 NTU

Invertebrate Summary

- There were 26 sites assessed on 23 streams
- Average scores for assessed sites range from 7 to 26, with a regional average of 17
- Only two sites rated as having Excellent water quality and two sites ranked as Poor

Invertebrate Rank	# of Sites
Excellent	2
Good	12
Fair	10
Poor	2
Total	26

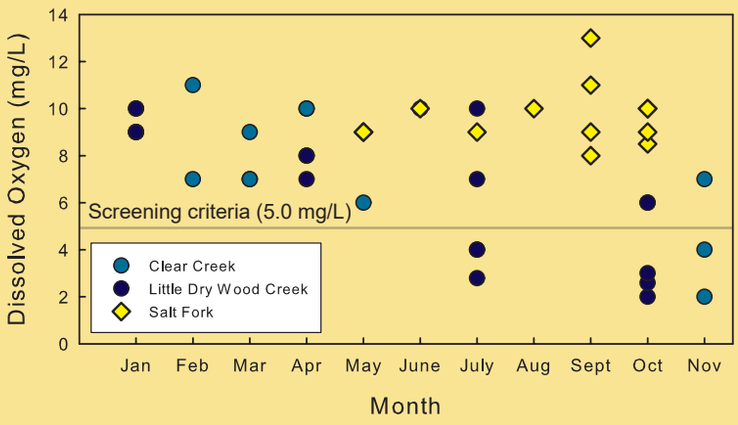


Regional Average = 17


ST 2800, Pearl River, Pettis County

Dissolved Oxygen by Month in Region 3

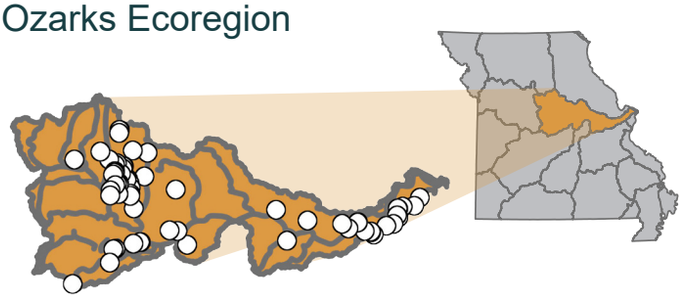
Individual dissolved oxygen readings (vertical axis) for three sites in the region are shown by the month of collection (horizontal axis). A site in the Salt Fork consistently had values above the screening criteria (horizontal line), while the other two sites (Clear Creek and Little Dry Wood Creek) showed much wider ranges of dissolved oxygen concentrations including values below the screening criteria. Interestingly, values below the criteria only occurred in three of the twelve months.




Indian Creek
Jackson County

Region 4 - Moreau & Loutre Rivers

Ozarks Ecoregion



Region 4 includes many smaller rivers and streams that drain directly into the lower Missouri River. Two of the largest rivers in the region are the Moreau and Loutre. This region covers mid-Missouri and extends eastward along the Missouri River into St. Louis County. Though land use is largely rural in the region, there are urban influences in St. Charles and St. Louis counties. The region also contains smaller urban areas (Columbia, Fulton, Jefferson City) which contain several urban stream sites.

Site averages exceeded screening criteria for four measured parameters in the region: dissolved oxygen (3 sites), nitrate (1 site), ammonia (1 site), and chloride (4 sites). These exceedances represent 2-6% of the assessed sites for three of the four parameters; average chloride values exceeded screening criteria in 25% of assessed sites.

There were five sites that had an average Turbidity value greater than 40 NTU (2 over 70 NTU)

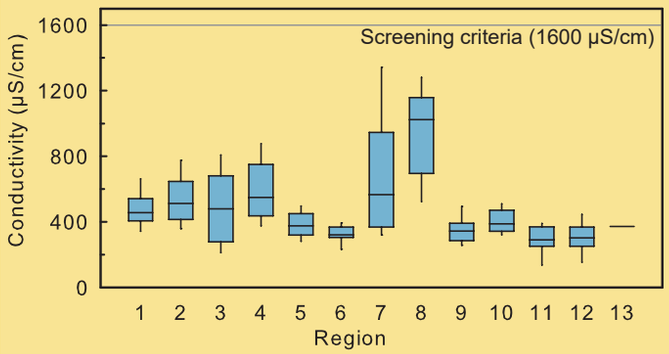
The regional average score of 19 for invertebrates puts this region on the low end of the statewide range, comparable to the Plains regions. This region had 34 sites that ranked Excellent or Good and 14 sites that ranked Fair or Poor.

This region is technically a mix between the Plains to the north and the Ozarks to the south, with the invertebrate scores reflecting that geographic distinction.

While there were sites that had water chemistry values of concern, none of the parameters seemed to be a large regional problem. The four sites that exceeded the chloride screening criterion of 230 mg/L were all located in urban areas.

ST 2504, Clear Creek, Boone County

A Statewide Look at: Conductivity



The graph shows the range of conductivity readings at assessed sites (vertical axis) by region (see page 9 for how to read a box plot).

Conductivity is influenced not only by geology, but also by human influences within the watershed. Elevated values from Regions 7 and 8 reflect sites located in urban/developed areas in St. Charles and St. Louis Counties. The Plains (Regions 1, 2 & 3) tend to have higher conductivity values than southern Missouri (Regions 6, 9, 10, 11 & 12).

Region 4 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	1641	1682	1418	403	253	424	1673	1241
Assessed Sites	64	65	58	18	7	16	61	48
Median (Assessed Sites)	9.9	7.9	0.37	0.38	0.36	72	550	16.3
Average (Assessed Sites)	9.6	7.9	0.54	0.42	0.47	137	622	24.1

Chemistry Summary

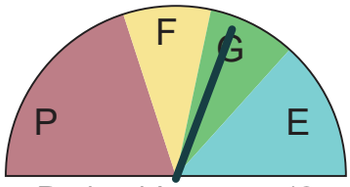
Reference values listed are screening criteria indicating values of potential concern.

- **DO**: 30 of the 64 assessed sites (47%) had average values over 10.0 mg/L, and 3 of the sites (4%) had average values less than 5.0 mg/L
- **pH**: Average values at all 65 assessed sites appear normal, ranging between 7.2 and 8.7
- **Nitrate**: 1 of the 58 assessed sites (2%) had average values over 2.0 mg/L
- **Ammonia**: 1 of the 18 assessed sites (6%) had average values over 1.0 mg/L
- **Phosphate**: None of the 7 assessed sites had an average value over 3.0 mg/L
- **Chloride**: 4 of the 16 assessed sites (25%) had average values over 230 mg/L
- **Conductivity**: None of the 61 assessed sites had an average value over 1600 µS/cm
- **Turbidity**: 5 of the 48 assessed sites (10%) had average values over 40 NTU, 2 averaged over 70 NTU

Invertebrate Summary

- There were 48 assessed sites on 31 different streams in this region
- Average scores for assessed sites range from 5 to 29, with a regional average of 19
- 34 sites (71%) received Good or Excellent scores
- 5 sites (10%) received Poor invertebrate scores

Invertebrate Rank	# of Sites
Excellent	7
Good	27
Fair	9
Poor	5
Total	48

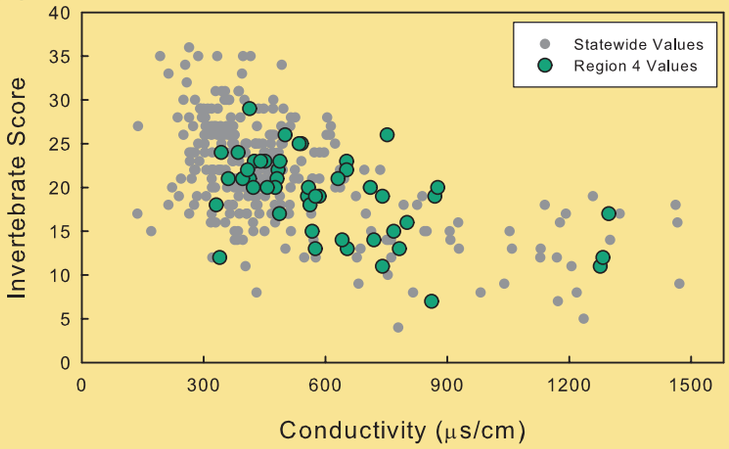


Regional Average = 19


ST 2760, Creve Coeur Creek, St. Louis County

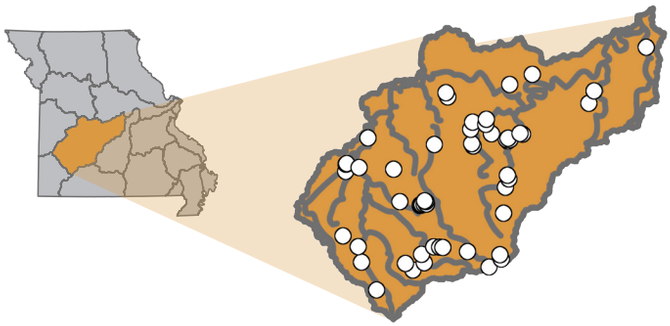
Invertebrate Scores vs. Conductivity in Region 4

Invertebrate scores (vertical axis) for both Region 4 and statewide are compared to conductivity readings (horizontal axis). Generally speaking, sites with conductivity values of 700 µS/cm or less display a wide range of invertebrate scores. When conductivity is above 800 µS/cm, invertebrate scores have an upper limit of around 20. Higher conductivity readings may signify water quality problems that negatively affect the aquatic invertebrate community. Data from Region 4 follows the statewide pattern.



Region 5 - Osage River

Ozarks Ecoregion



Region 5 includes the Sac and Pomme de Terre rivers, which flow north from the Springfield area and feed into Truman Lake, the Niangua and Little Niangua rivers flowing into Lake of the Ozarks, and a section of the Osage River. This region extends from northern Springfield northeast towards Jefferson City. The southern portion of this region is dominated by grassland/pasture, transitioning into a more forest-dominated landscape as it extends to the Lake of the Ozarks area.

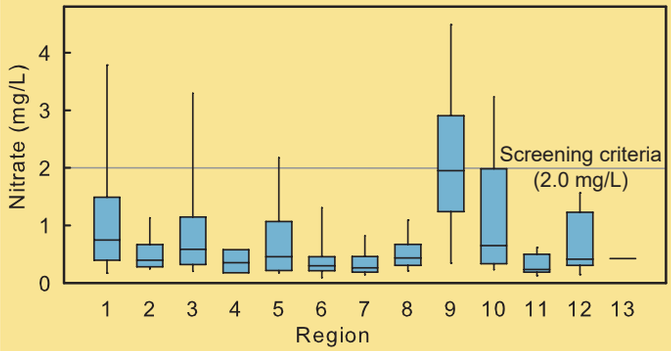
Six of 53 sites (11%) evaluated for nitrate in the region had an average value exceeding the screening criterion. The maximum site average nitrate concentration was 11.5 mg/L, more than five times the screening criterion of 2.0 mg/L. None of the sites had an exceedance for any of the other water chemistry parameters for which screening criteria exist.

Just one site in the region had an average turbidity value greater than 40 NTU.

With an average invertebrate score of 24, the region falls in the Excellent category overall. Of the 49 sites evaluated for invertebrates, 44 scored Excellent (25 sites) or Good (19 sites).

ST 313, Little Niangua River, Camden County

A Statewide Look at: Nitrate



Here we show the range of nitrate concentrations (vertical axis) at assessed sites in each region (see page 9 for how to read a box plot).

Interestingly, the three regions with the most nitrate are Region 1 in northwest Missouri and Regions 9 and 10 in the southwest part of the state.

Region 5 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	923	888	858	142	246	49	786	548
Assessed Sites	54	53	53	9	19	1	51	37
Median (Assessed Sites)	9.7	8.0	0.46	0.09	0.32	15	376	12.9
Average (Assessed Sites)	9.7	8.0	0.95	0.17	0.55	15	389	15.3

Chemistry Summary

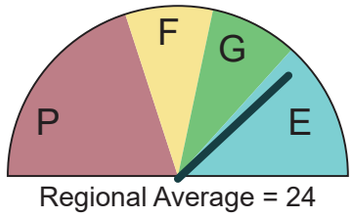
Reference values listed are screening criteria indicating values of potential concern.

- **DO**: 21 of the 54 assessed sites (39%) had a very healthy average value of 10.0 mg/L or more; none of the sites had an average value of concern (less than 5 mg/L)
- **pH**: Average pH values at the 53 assessed sites exhibited a narrow range (7.9 to 8.3)
- **Nitrate**: 6 of the 53 assessed sites (11%) had average values over 2.0 mg/L
- **Ammonia**: None of the 9 assessed sites had average values over 1.0 mg/L
- **Phosphate**: None of the 19 assessed sites had average values over 3.0 mg/L
- **Chloride**: The 1 assessed site had an average value of 31 mg/L, well below the screening criterion (230 mg/L)
- **Conductivity**: All 51 assessed sites had average values below 600 µS/cm, well below the screening criterion (1600 µS/cm)
- **Turbidity**: 10 of the 37 assessed sites (27%) had very low average values close to 10 NTU; only 1 site averaged more than 40 NTU

Invertebrate Summary

- There were 49 sites assessed on 27 streams
- Average scores for assessed sites range from 14 to 34, with a regional average of 24
- More than half of the region's sites (51%) were assessed as having Excellent water quality
- None of the sites had a Poor water quality score, and only 5 sites (10%) scored Fair

Invertebrate Rank	# of Sites
Excellent	25
Good	19
Fair	5
Poor	0
Total	49

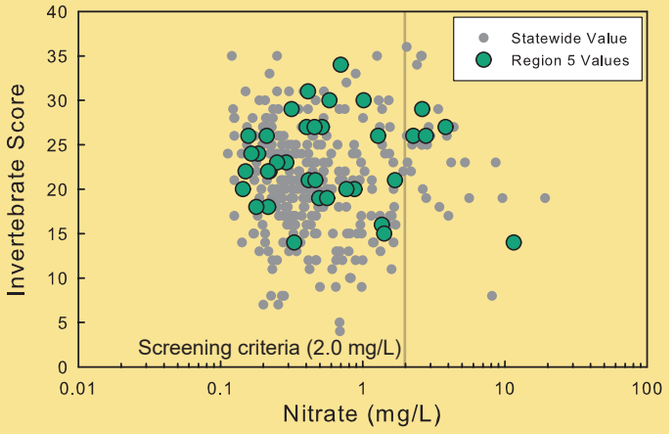


Regional Average = 24


ST 4193, Bennett Spring, Dallas County

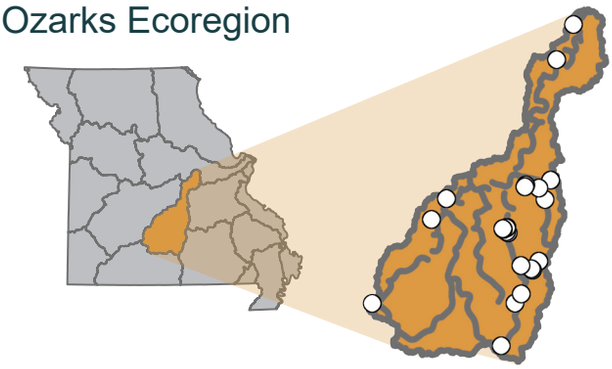
Invertebrate Scores vs. Nitrate in Region 5

Invertebrate scores (vertical axis) for both Region 5 and statewide are compared to nitrate concentrations (horizontal axis). Most sites, both statewide and in Region 5, have values below the screening criteria of 2.0 mg/L (vertical line). While high invertebrate scores do occur even when nitrate is greater than 2.0 mg/L, scores appear to decrease with further increasing nitrate concentrations.



Region 6 - Gasconade River

Ozarks Ecoregion



All of the Gasconade River's approximately 300 miles, along with its major tributaries – the Big Piney and Osage Fork of the Gasconade, are located in Region 6. This region starts north of Highway 60 between Springfield and Cabool and stretches northeast past Rolla. A mix of forest and grassland covers the southern portion of the region, with a shift toward a more forest-dominant landscape in the north. The vast majority of sites in Region 6 are rural, with very little urban influences.

Only one site in the region exceeded any chemistry screening criteria. This site had an average phosphate concentration of 7.1 mg/L, more than double the criterion of 3.0 mg/L.

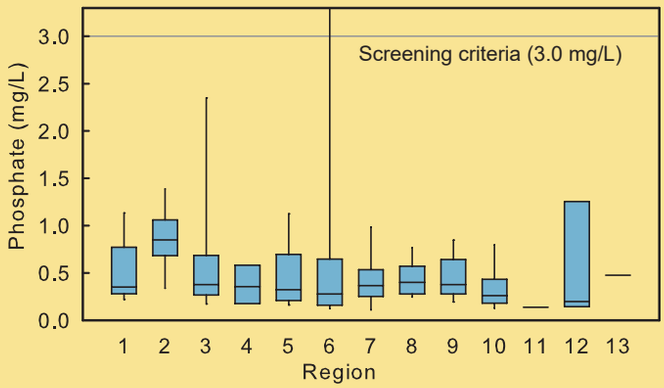
None of the 15 sites evaluated for turbidity in Region 6 had an average that exceeded 40 NTU, with the maximum site average of 26.4 NTU.

Invertebrate scores averaged 25 (Excellent), putting this region into the top four across the state. Excellent scores dominate, with 17 of 23 sites (74%) having scores greater than 23.

This region had, overall, some of the best water quality in the state. Only one other region had fewer screening criteria exceedances, and no other region had a higher rate of Excellent scores for invertebrate monitoring.

ST 1293, Beaver Creek, Phelps County

A Statewide Look at: Phosphate



This graph shows the range of phosphate concentrations at assessed sites (vertical axis) by region (see page 9 for how to read a box plot).

Phosphate in the Plains regions (1-3) differed from the other nutrients (nitrate and ammonia) in that Region 2 had the highest phosphate, while generally having lower nitrate and ammonia compared to Region 1 and 3. These results may reflect differences in soil types among the regions.

Region 6 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	385	372	358	169	126	13	353	255
Assessed Sites	24	24	22	11	9	1	24	15
Median (Assessed Sites)	10.2	8.0	0.33	0.08	0.28	25	320	10.0
Average (Assessed Sites)	10.1	7.9	0.50	0.20	1.06	25	340	11.3

Chemistry Summary

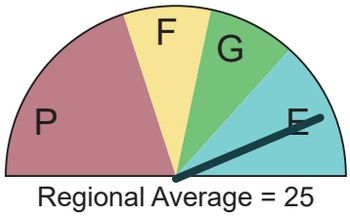
Reference values listed are screening criteria indicating values of potential concern.

- **DO**: None of the 24 assessed sites had an average value of concern (less than 5 mg/L)
- **pH**: Average values at the 24 assessed sites exhibited a normal range (7.4 to 8.3)
- **Nitrate**: 17 of the 22 assessed sites (77%) had average values of 0.5 mg/L or less; none were greater than 2.0 mg/L
- **Ammonia**: None of the 11 assessed sites had an average value over 1.0 mg/L
- **Phosphate**: 1 assessed site (out of 9) had an average value over 3.0 mg/L
- **Chloride**: There were only 13 measurements made in Region 6; the maximum value was 33 mg/L, well below a level of concern
- **Conductivity**: All 24 assessed sites had average values well below the screening criterion (1600 µS/cm), with a maximum site average of 804 µS/cm
- **Turbidity**: None of the 15 assessed sites had an average value greater than 40 NTU (maximum was 26.4 NTU)

Invertebrate Summary

- There were 23 assessed sites on 11 streams in Region 6

Invertebrate Rank	# of Sites
Excellent	17
Good	6
Fair	
Poor	
Total	23



Regional Average = 25

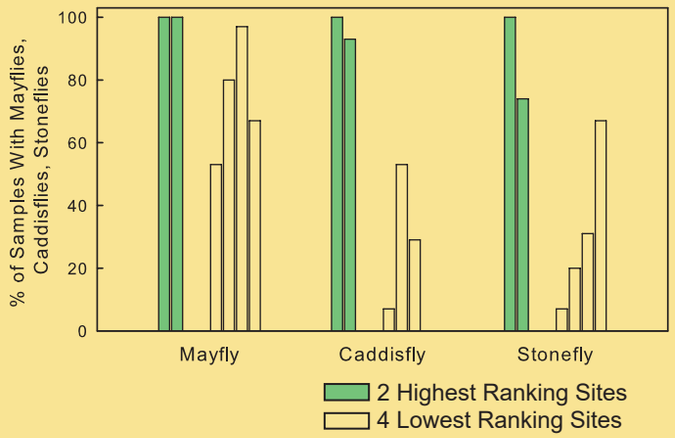

ST 4510, Mill Creek, Phelps County

- Average scores for assessed sites range from 19 to 33, with a regional average of 25
- 30% of assessed sites in the region (7) are on the Big Piney River
- Water quality in all of the sites rated as either Excellent (17 sites) or Good (6 sites)

Invertebrate Types in Region 6

The two sites with the highest overall invertebrate scores (30+) are compared to four sites with the lowest scores (19 – 23) in the region. Bars show the percent of kick net samples that contained three indicators of good water quality: mayflies, caddisflies and stoneflies.

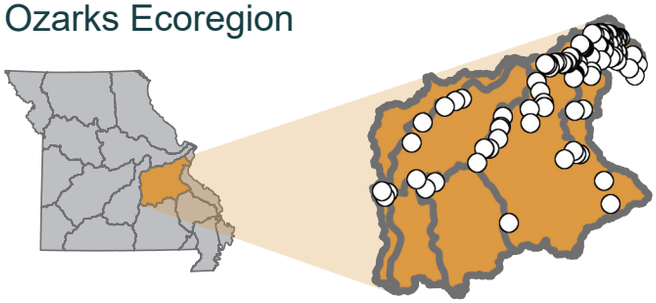
These groups of inverts show up in the vast majority of kick net samples in the highest scoring sites. In the poorer scoring sites these invertebrates, particularly caddisflies and stoneflies, are much less frequently found.




Big Piney River
Texas County

Region 7 - Meramec River

Ozarks Ecoregion



Region 7 encompasses the entire Meramec River watershed, including its major tributaries, the Big River and the Bourbeuse River. The southern edge of Region 7 extends east from Rolla towards Farmington and then north into the St. Louis area. Sites in the region are a mix of those in urban areas and those in rural landscapes (mixed forest and grassland).

This region had screening criteria exceedances for five different water quality parameters (nitrate, ammonia, phosphate, conductivity, and chloride). However, there were only one or two sites in each case that registered high values, with the exception of chloride, which had 14 sites (31%) exceeding screening criterion. Urban influences in the St. Louis area explain the relatively high number of sites with elevated chloride.

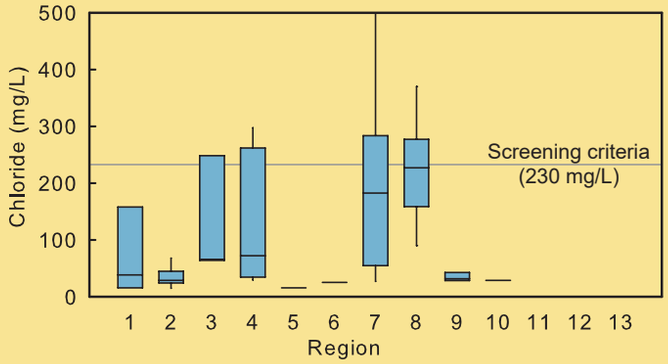
There were six sites that had average turbidity values greater than 40 NTU, including one exceeding 70 NTU.

The regional average invertebrate score of 19 puts this region in the middle of the statewide range. There were 36 sites that rated as Excellent or Good, with the remaining 23 sites rated Fair or Poor (15 and 8, respectively).

Region 7 is the most monitored, with the most sites evaluated for all of the water chemistry parameters except ammonia. There were 59 sites assessed for invertebrates, third most in the state (two regions had 63 sites).

ST 4109, Bourbeuse River, Phelps County

A Statewide Look at: Chloride



Here we show the range of chloride concentrations (vertical axis) for each region (see page 9 for how to read a box plot).

Chloride is not measured at all sites, and is often measured at sites where chloride problems might be expected. The two regions with the highest median values (horizontal line within box) are also the two regions with the most sites monitoring chloride (regions 7 and 8, both which have many sites with urban influences).

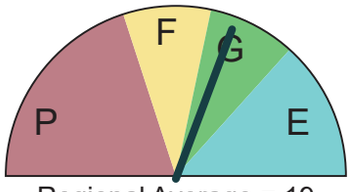
Region 7 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	1969	2544	2084	769	1338	1405	2857	1968
Assessed Sites	94	95	90	39	54	45	98	79
Median (Assessed Sites)	9.8	8.0	0.26	0.14	0.37	182	566	11.3
Average (Assessed Sites)	9.7	8.0	0.42	0.34	0.49	235	701	18.1

Chemistry Summary

Reference values listed are screening criteria indicating values of potential concern.

- **DO:** 45 of the 94 assessed sites (48%) – almost half – had a very healthy average value of 10.0 mg/L or more; none of the sites had an average value of concern (less than 5 mg/L)
- **pH:** Average values at the 95 assessed sites exhibited a normal range (7.2 to 8.6)
- **Nitrate:** 70 of the 90 assessed sites (78%) had a very healthy average value of 0.50 mg/L or less; only 2 sites averaged over 2.0 mg/L
- **Ammonia:** Only 1 assessed site (out of 39) had an average value over 1.0 mg/L
- **Phosphate:** Only 1 assessed site (out of 54) had an average value over 3.0 mg/L
- **Chloride:** 14 of the 45 assessed sites (31%) had average values over 230 mg/L
- **Conductivity:** Only 1 assessed site (out of 98) had an average value over 1600 µS/cm
- **Turbidity:** 6 of the 79 assessed sites (8%) had an average value of 40 NTU or more

Invertebrate Rank	# of Sites
Excellent	15
Good	21
Fair	15
Poor	8
Total	59



Regional Average = 19

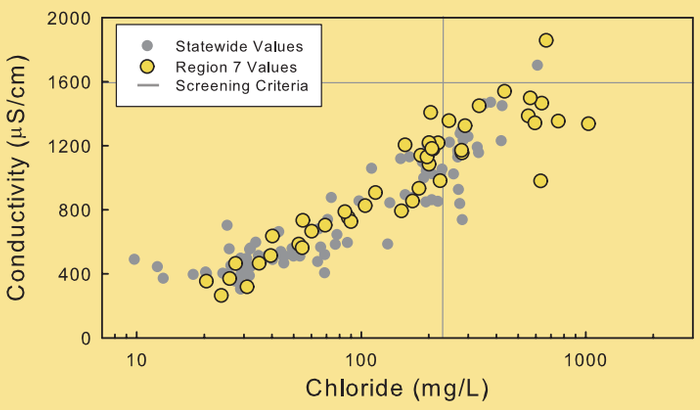

ST 3211, Grand Glaize Creek, St. Louis County

Invertebrate Summary

- There were 59 sites assessed on 26 streams
- Average scores for assessed sites range from 4 to 31, with a regional average of 19
- The lowest scoring site, located on Williams Creek, St. Louis County, was sampled in 11 different years, with scores ranging from 2 to 10

Conductivity vs. Chloride in Region 7

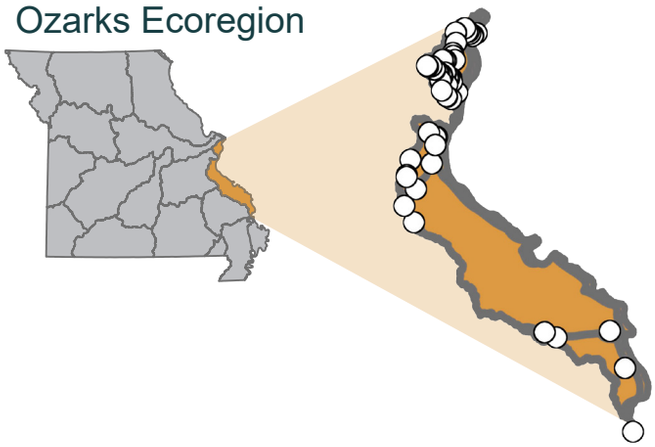
Here we compare conductivity measurements (vertical axis) to chloride concentrations (horizontal axis). Screening criteria are indicated by the lines in the graphic. Region 7 sites show a positive relation between these two water quality parameters: as chloride concentrations increase, so does the conductivity. Conductivity could be used as a potential indicator for chloride in this region, but the screening criterion for conductivity would need to be lowered to about 1200 µS/cm (so the two criteria lines cross within the data).




Meramec River
Franklin County

Region 8 - River des Peres, Apple, & Joachim Creeks

Ozarks Ecoregion



Unlike the other regions in this report, Region 8 does not encompass the whole of a major river watershed, but instead is made up of tributaries that flow into a portion of the Mississippi River. This region is relatively small in size, stretching southward from St. Louis along the Mississippi River to Cape Girardeau. Land cover varies, with urban influences in the north, grassland/pasture in the south, and forest in between.

Screening criteria exceedances occurred for conductivity (1 site), ammonia (3 sites), and chloride (15 sites). The 15 sites with high chloride concentrations represent 47% of the sites that were assessed for this parameter in the region.

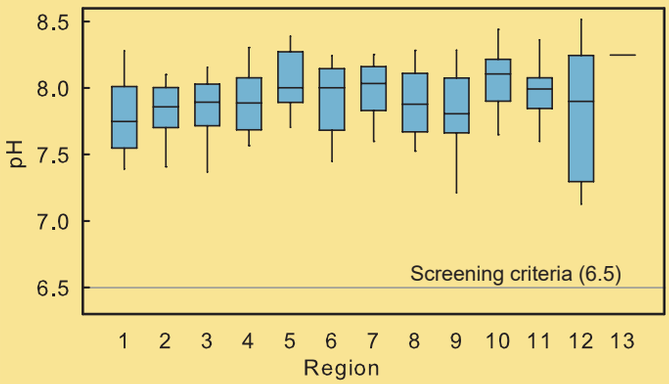
Only three of the 49 sites evaluated for turbidity had average values that were higher than 40 NTU.

The regional average invertebrate score of 18 places Region 8 in the lower end of the statewide gradient.

Chloride monitoring is targeted toward sites where a problem is perceived or expected. This region contains many urban sites, which helps explain both the higher percentage of sites that exceed the chloride screening criterion and the lower invertebrate scores.

ST 3745, Tributary to River des Peres, St. Louis County

A Statewide Look at: pH



Here we show the range of pH readings (vertical axis) for assessed sites in each region (see page 9 for how to read a box plot).

Notice that the box (middle 50% of data) ranges generally overlap, indicating that pH values tend to be similar from region to region. Regions 5, 6, 7, and 10 had the highest median (line in box) pH readings. Region 12 had the greatest range of pH values

Region 8 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	1693	1913	1493	217	363	1381	2017	1566
Assessed Sites	62	60	52	14	19	32	59	49
Median (Assessed Sites)	9.6	7.9	0.43	0.20	0.40	227	1023	13.1
Average (Assessed Sites)	9.6	8.9	0.55	0.66	0.43	232	951	16.9

Chemistry Summary

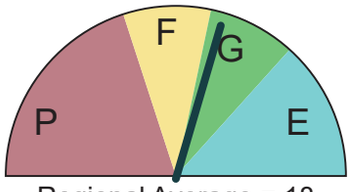
Reference values listed are screening criteria indicating values of potential concern.

- **DO**: 27 of the 62 assessed sites (44%) had a very healthy average value of 10.0 mg/L or more; none of the sites had an average value of concern (less than 5 mg/L)
- **pH**: Average values at the 60 assessed sites ranged from 7.3 to 9.0
- **Nitrate**: None of the 52 assessed sites had an average value over 2.0 mg/L
- **Ammonia**: 3 of the 14 assessed sites (21%) had average values over 1.0 mg/L
- **Phosphate**: None of the 19 assessed sites had an average value over 3.0 mg/L
- **Chloride**: 15 of the 32 assessed sites (47%) – nearly half – had average values over 230 mg/L
- **Conductivity**: Only 1 assessed site (out of 59) had an average value over 1600 µS/cm
- **Turbidity**: 3 of the 49 assessed sites (6%) had an average value of 40 NTU or more

Invertebrate Summary

- There were 31 assessed sites on 17 streams
- Average scores for assessed sites range from 5 to 35, with a regional average of 18

Invertebrate Rank	# of Sites
Excellent	5
Good	9
Fair	14
Poor	3
Total	31



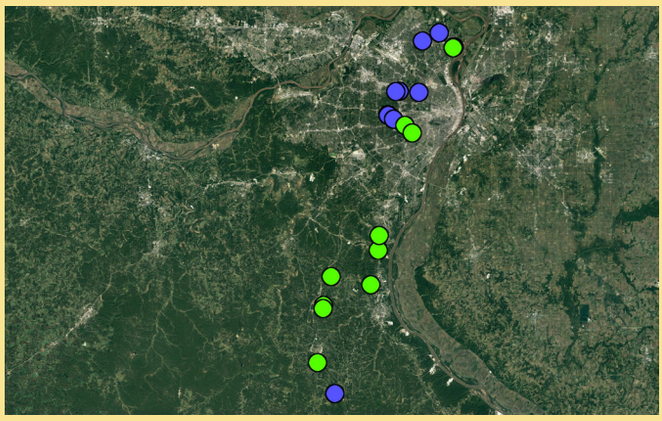
Regional Average = 18


ST 5256, Isle du Bois Creek, Ste. Genevieve County

- All three sites that had Poor water quality ratings were located on River des Peres, St. Louis County
- Scores from 74% of sites ranked as having Good (9) or Fair (14) water quality

pH in Region 8

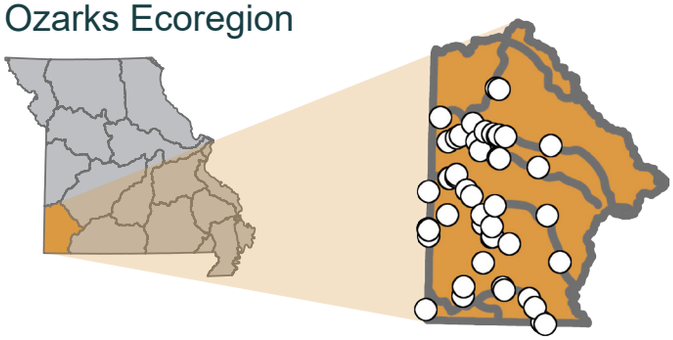
The photo below shows the 10 sites in Region 8 with the lowest pH (blue dots, average pH 7.47) and the 10 sites with the highest pH (green dots, average pH 8.39). While the average values differ by less than 1 unit on the pH scale, remember that each unit change on that scale represents a 10-fold change in the level of acidity. The sites with the lowest pH are all, save one, in the urban St. Louis area.




Grand Glaize Creek
St. Louis County

Region 9 - Neosho River

Ozarks Ecoregion



Region 9 bounds Missouri's portion of the Neosho River watershed. This southwest region includes the smaller watersheds of Spring River, Shoal Creek, and Elk River. This region has mixed land cover, with a north to south shift from agriculture to grassland and then forest. Some sites are located near the Joplin/ Webb City urban center.

Nitrate concentrations are high in Region 9. Of the 47 sites evaluated for nitrate, 23 (49%) exceeded the screening criterion of 2.0 mg/L. The only other screening criteria exceedance was for ammonia, with only one site out of 28 being above 1.0 mg/L.

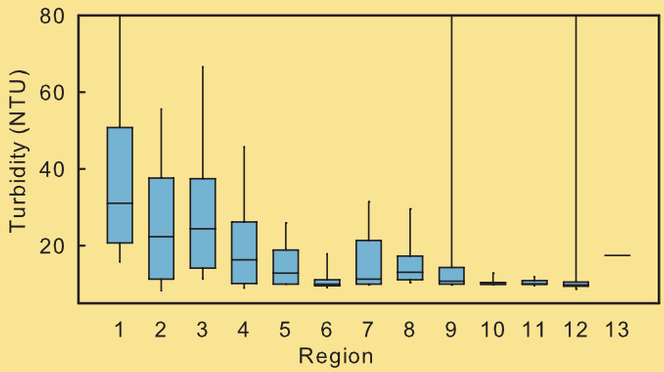
There were four sites out of 27 that had average turbidity values greater than 70 NTU.

In terms of invertebrates, the regional average was 25 which put it in the top four among the regions. Two-thirds of the sites rated as Excellent, with no sites ranking as Poor.

Water quality in this region is good with great invertebrate scores and, with the exception of nitrate, minimal exceedance of screening criteria. Six sites in the region had average nitrate values greater than 4.0 mg/L, which is twice the screening criterion (maximum site average was 9.5 mg/L).

View of Shoal Creek from one of the several trails at Wildcat Glades Park, Newton County

A Statewide Look at: Turbidity



This plot shows the range of turbidity readings at assessed sites (vertical axis) by region (see page 9 for how to read a box plot).

Turbidity values reflect a north to south gradient that we expect due to differences in land cover and land use. Streams in the Plains (Regions 1-3) tend to be more turbid than the substantially clearer streams of the Ozarks, with intermediate conditions in mid-Missouri.

No screening criteria was used for Turbidity.

Region 9 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	1062	1139	1143	607	867	111	1146	677
Assessed Sites	41	41	47	28	29	5	37	27
Median (Assessed Sites)	9.4	7.8	1.95	0.11	0.38	32	345	10.7
Average (Assessed Sites)	9.5	7.8	2.29	0.23	0.48	35	368	36.8

Chemistry Summary

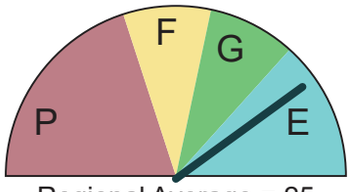
Reference values listed are screening criteria indicating values of potential concern.

- **DO**: None of the 41 assessed sites had an average value of concern (less than 5 mg/L)
- **pH**: Average values at the 41 assessed sites ranged from 7.0 to 8.7
- **Nitrate**: 23 of the 47 assessed sites (49%) – nearly half – had average values over 2.0 mg/L
- **Ammonia**: Only 1 assessed site (out of 28) had an average value over 1.0 mg/L
- **Phosphate**: None of the 29 assessed sites had an average value over 3.0 mg/L, and only 1 site average exceeded 1.0 mg/L
- **Chloride**: All 5 assessed sites had average values less than 45 mg/L, well below the screening criterion (230 mg/L)
- **Conductivity**: None of the 37 assessed sites had an average value over 1600 µS/cm
- **Turbidity**: 8 of the 27 assessed sites had very low turbidity (close to 10 NTU) and 4 had very high turbidity (greater than 70 NTU)

Invertebrate Summary

- There were 27 sites assessed on 15 streams
- Average scores for assessed sites range from 14 to 36, with a regional average of 25

Invertebrate Rank	# of Sites
Excellent	18
Good	5
Fair	4
Poor	
Total	27



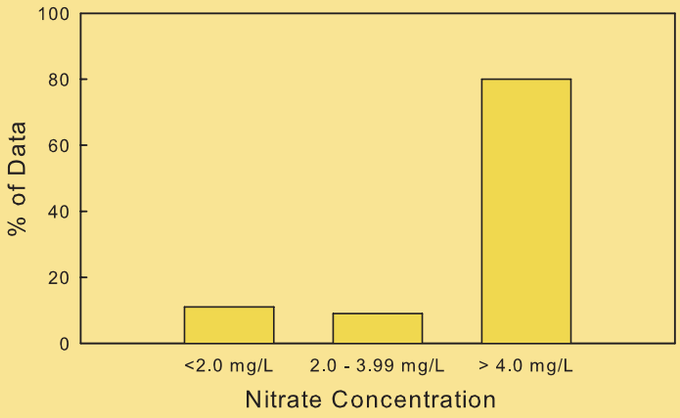
Regional Average = 25


ST 3714, Silver Creek, Newton County

- 67% of sites received an Excellent water quality score
- None of the sites were assessed as Poor, and only 4 earned a Fair invertebrate score

High Nitrate Concentrations in Region 9

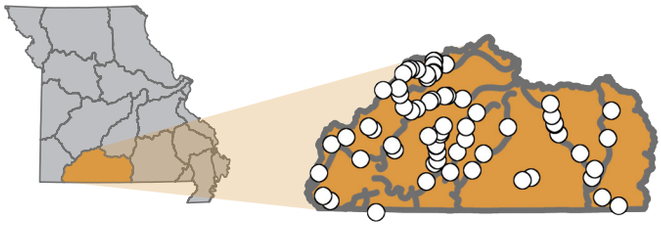
There were 11 sites in the region that had an average nitrate level of 3.0 mg/L or greater. Out of the 367 nitrate measurements taken at these sites, 293 (80%) were greater than 4.0 mg/L. Only 11% of the samples measured less than screening criterion of 2.0 mg/L. These data indicate that elevated nitrate levels are a consistent problem at these sites, with the vast majority of samples having more than twice the concentration that would be considered a potential water quality concern.




Silver Creek
Newton County

Region 10 - White River

Ozarks Ecoregion



Rivers in Region 10 all drain south into the White River, and include Flat Creek, the James River, the North Fork of the White River, and Bryant Creek. This region includes the southern portion of Springfield and extends south to the Arkansas border. Most of the region is forested, though there is a substantial amount of grassland and pasture in the upper James River watershed. While urban land cover is limited in the region, about a third of the sites are located in the greater Springfield area or downstream from the city and thus have urban influences.

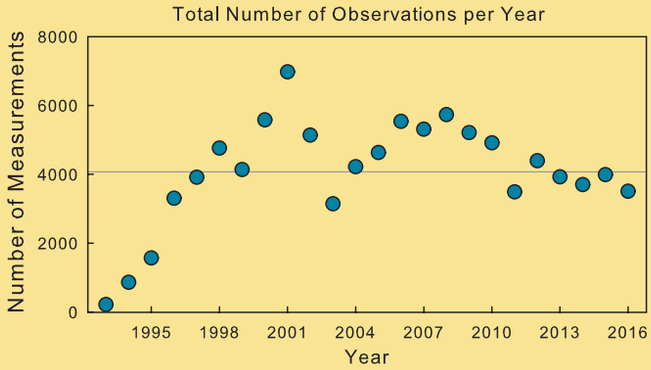
Region 10, much like Region 9, has a considerable number of sites with elevated nitrate levels. Of the 65 sites assessed, 16 of them (25%) exceeded the screening criteria of 2.0 mg/L. The only other parameter with an excursion above criterion was conductivity, where one site averaged above 1600 µS/cm.

The overall regional average invertebrate score was 25, giving it the fourth highest score in the state. Sixty-three percent of the sites had a water quality ranking of Excellent based on invertebrates, with only one Poor rated site.

Water quality in Region 10 is good, with 92% of sites yielding an Excellent or Good rating for invertebrates. The elevated nitrate levels that occur in a quarter of the sites are a concern.

ST 4325, Roark Creek, Taney County

A Look at: Stream Team Data Quantity



This graph shows the total number of samples (dissolved oxygen, pH, conductivity, nitrate, ammonia, phosphate, chloride, turbidity, invertebrate) collected each year by Stream Team volunteers.

Stream Team monitoring was at its highest in 2001, but monitoring effort varied considerably from year to year. In recent years, monitoring effort has been consistently near the long term average (horizontal line). It is likely that all 2016 activity was not reported by the time the data were compiled.

Region 10 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	2639	2626	2483	214	503	88	2422	1229
Assessed Sites	68	66	65	13	22	7	62	50
Median (Assessed Sites)	10.3	8.1	0.65	0.24	0.26	29	388	10.0
Average (Assessed Sites)	10.2	8.1	1.33	0.19	0.37	35	430	11.2

Chemistry Summary

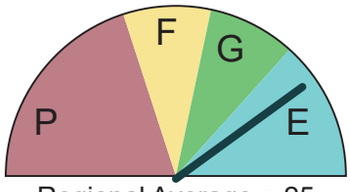
Reference values listed are screening criteria indicating values of potential concern.

- **DO:** None of the 68 assessed sites had an average value of concern (less than 5 mg/L); all sites averaged 7.7 mg/L or greater, and 42 sites (62%) averaged a very healthy 10.0 mg/L or more
- **pH**: Of the 66 assessed sites, 1 had an average value that was greater than 9.5 (none were less than 6.5)
- **Nitrate**: 16 of the 65 assessed sites (25%) had average values over 2.0 mg/L
- **Ammonia**: None of the 13 assessed sites had an average value over 1.0 mg/L (maximum was 0.48 mg/L)
- **Phosphate**: None of the 22 assessed sites had an average value over 3.0 mg/L
- **Chloride**: None of the 7 assessed sites had an average value over 230 mg/L (range 29 to 69 mg/L)
- **Conductivity**: Only 1 assessed site (out of 62) had an average value over 1600 µS/cm
- **Turbidity**: 29 of the 50 assessed sites (58%) had very low average values close to 10 NTU (maximum was 31.6 NTU)

Invertebrate Summary

- There were 63 sites assessed on 25 streams
- Average scores for assessed sites range from 8 to 35, with a regional average of 25

Invertebrate Rank	# of Sites
Excellent	40
Good	18
Fair	4
Poor	1
Total	63



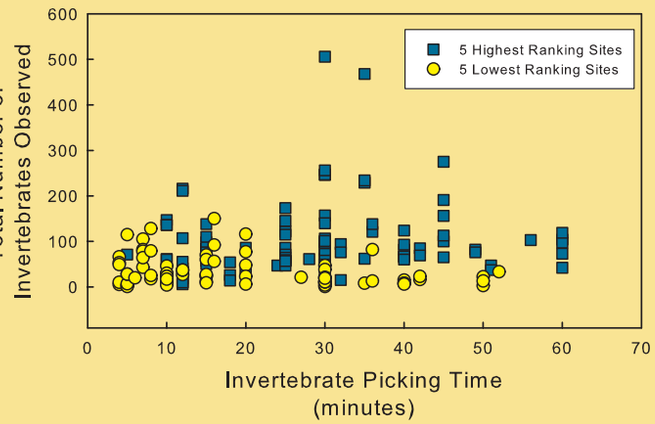
Regional Average = 25


ST 4325, Roark Creek, Taney County

- 92% of sites had either Excellent or Good water quality scores
- Only one site was rated as having Poor water quality

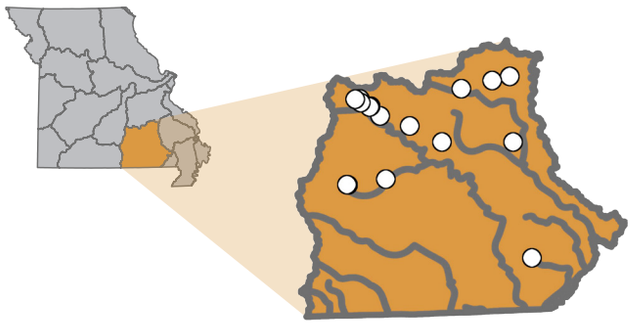
Invertebrates Observed vs. Time Spent Picking in Region 10

Here we show the total number of invertebrates in each kick net sample (vertical axis) relative to the amount of time spent picking invertebrates from the net (horizontal axis) for the five highest and five lowest scoring sites in the region. While there is some overlap in the data points, there is an indication that more time is spent at sites with higher scores, while less time is spent at sites with lower scores. We don't know if the lower scores are due to less effort or if there were simply fewer invertebrates to be identified.



Region 11 - Black & Current Rivers

Ozarks Ecoregion



Region 11 contains the Current, Jacks Fork, Eleven Point, and Black rivers and their tributaries. This region encompasses the area south of Salem, with Poplar Bluff as the eastern edge and West Plains as the western edge. The region is heavily dominated by forest; however, grassland and pasture are common to the south.

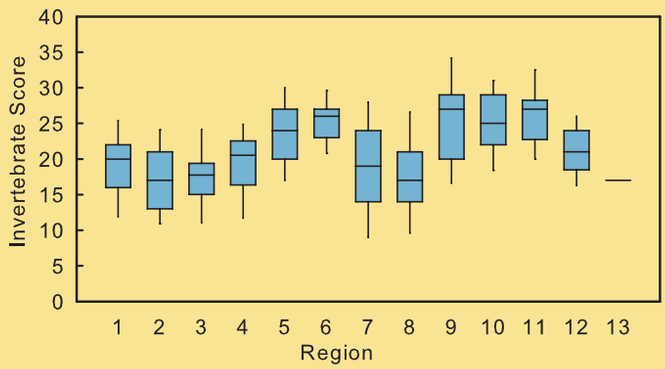
Region 11 did not have as many assessed sites as most other regions. Dissolved oxygen and pH had the most assessed sites in the region, with 17 sites each. None of the water chemistry parameters had any sites that exceeded the screening criteria and turbidity was low.

The regional average invertebrate score of 26 was the highest of the regions. All 14 assessed sites rated as either Excellent (9) or Good (5).

The invertebrate scores suggest Region 11 has the best water quality in the state. This would not be surprising given the region is home to the Ozark and Eleven Point National Scenic Riverways. The chemistry data also indicate good water quality. Unfortunately, the low number of assessed sites makes it difficult to compare this region to the others evaluated (only Regions 12 and 13 have fewer sites).

ST 31, Current River, Shannon County

A Statewide Look at: Invertebrate Scores



This box plot shows the range of invertebrate scores at assessed sites (vertical axis) by region (see page 9 for how to read a box plot).

The southern Ozarks regions tended to have higher average invertebrate scores than the northern Plains regions. The lower scores in regions 7 and 8 are likely the result of urban-influenced sites in the greater St. Louis area.

Region 11 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	405	442	352	51	40	2	332	253
Assessed Sites	17	17	15	3	2	0	16	10
Median (Assessed Sites)	11.0	8.0	0.24	0.35	0.14		291	10.0
Average (Assessed Sites)	11.0	8.0	0.32	0.26	0.14		290	10.4

Chemistry Summary

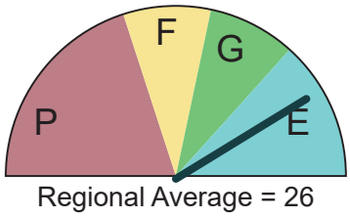
Reference values listed are screening criteria indicating values of potential concern.

- **DO**: None of the 17 assessed sites had an average value of concern (less than 5 mg/L)
- **pH**: Average values at the 17 assessed sites exhibited a normal range (7.6 to 8.5)
- **Nitrate**: None of the 15 assessed sites had an average value over 2.0 mg/L (maximum was 0.75 mg/L)
- **Ammonia**: Only 3 sites had enough data for assessment; averages were well below screening criteria (1.0 mg/L)
- **Phosphate**: Only 2 sites had enough data for assessment, with average values of 0.12 and 0.16 mg/L, well below the screening criteria (3.0 mg/L)
- **Chloride**: No sites had sufficient data for assessment, but the 2 measurements taken were less than 25 mg/L
- **Conductivity**: None of the 16 assessed sites had an average value over 1600 µS/cm; averages ranged from 132 to 400 µS/cm
- **Turbidity**: 6 of the 10 assessed sites (60%) had very low average values close to 10 NTU

Invertebrate Summary

- There were 14 sites assessed on 11 streams

Invertebrate Rank	# of Sites
Excellent	9
Good	5
Fair	
Poor	
Total	14



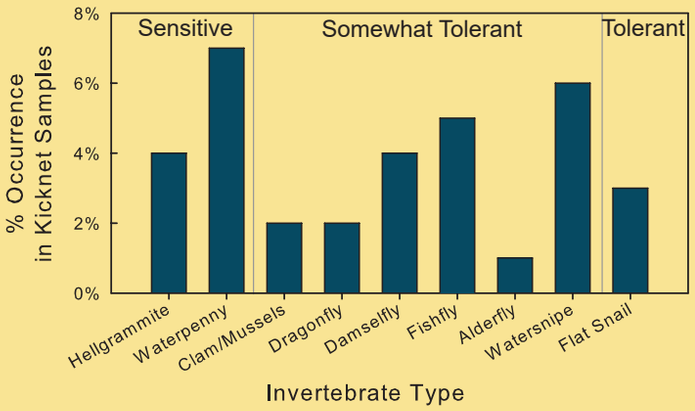
Regional Average = 26


ST 31, Current River, Shannon County

- Average scores for assessed sites range from 19 to 35, with a regional average of 26
- All sites were rated as having either Excellent (9) or Good (5) water quality

Infrequent Invertebrates in Region 11

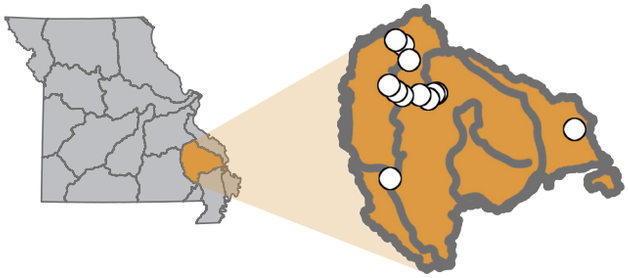
We examined kick net samples from four sites in the Current River to determine how often the 24 different invertebrate groups were found. This graph shows the nine groups with the lowest occurrences (7% or less). Alderfly larvae were the least found invertebrate, showing up in 1 of 104 samples (1%). This low rate of occurrence may reflect habitat preferences of this organism, which is soft sediment with organic matter (leaf litter). Habitat preference may also explain the low rates of occurrence of some of the other invertebrates.




Current River
Ripley County

Region 12 - Upper St. Francis & Castor Rivers

Ozarks Ecoregion



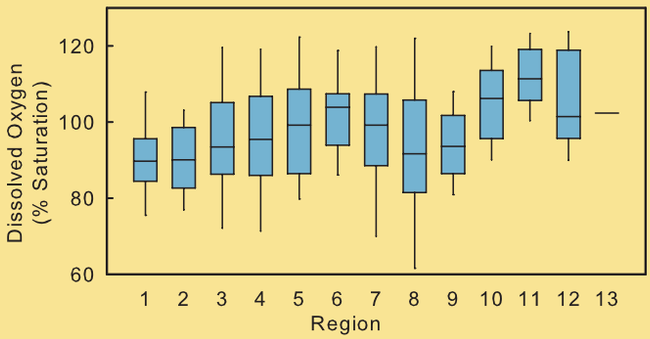
Geographically, Region 12 forms a triangle connecting Farmington, Poplar Bluff, and Cape Girardeau and represents the watershed of the Castor River and the upper portion of the St. Francis River. The region includes the granitic St. Francois Mountains and is primarily forested with some grassland and pasture to the east.

Region 12 is under-monitored compared to most of the other regions. Only 13 sites have been sampled sufficiently for water chemistry assessment. None of the parameters exceed screening values, and only one site had high average turbidity. The overall regional average invertebrate score was 21, putting this region in the middle when compared to the other regions. Half of the 12 sites evaluated for invertebrates ranked as Good, with four Excellent and two Fair.

Due to limited data, it is difficult to make comparisons between Region 12 and the other regions. The data that are available do not indicate any regional water quality issues.

ST 5268, Hubble Creek, Cape Girardeau County

A Statewide Look at: DO Saturation



In this box plot we show the range of dissolved oxygen saturation values at assessed sites (vertical axis) by region (see page 9 for how to read a box plot).

Dissolved oxygen saturation differs from concentration (box plot on page 14) in that it is dependent on water temperature. For example, a dissolved oxygen reading of 8 mg/L would be 89% saturation at 18°C and 105% at 27°C. The graph shows that DO was below 100% more than 75% of the time in Regions 1 and 2. Notice that at least half of the readings in Regions 6, 10, 11, and 12 were above 100% saturation.

Region 12 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	199	198	188	95	38	4	179	146
Assessed Sites	13	13	13	9	4	0	11	10
Median (Assessed Sites)	10.0	7.9	0.42	0.09	0.20		303	9.8
Average (Assessed Sites)	9.9	7.8	0.68	0.15	0.53		308	21.0

Chemistry Summary

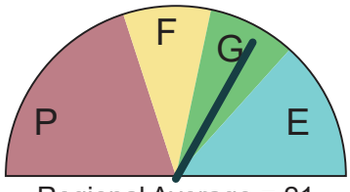
Reference values listed are screening criteria indicating values of potential concern.

- **DO**: All of the 13 assessed sites had an average value of at least 8.1 mg/L
- **pH**: Average values at the 13 assessed sites exhibited a normal range (7.1 to 8.6)
- **Nitrate**: None of the 13 assessed sites had an average value over 2.0 mg/L
- **Ammonia**: None of the 9 assessed sites had an average value over 1.0 mg/L (maximum average value was 0.49 mg/L)
- **Phosphate**: None of the 4 assessed sites had an average value over 1.0 mg/L
- **Chloride**: No sites had sufficient data for assessment, but the 4 measurements taken were less than 50 mg/L
- **Conductivity**: None of the 11 assessed sites had an average value over 1600 µS/cm; averages ranged from 137 to 447 µS/cm
- **Turbidity**: 6 of the 10 assessed sites (60%) had very low average values close to 10 NTU; 1 site averaged over 70 NTU

Invertebrate Summary

- There were 12 sites assessed on 7 streams
- Average scores for assessed sites range from 16 to 26, with a regional average of 21
- No sites received a Poor invertebrate score

Invertebrate Rank	# of Sites
Excellent	4
Good	6
Fair	2
Poor	
Total	12

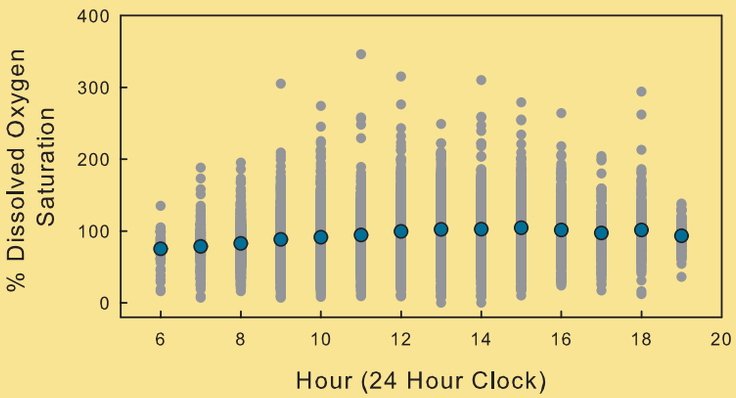


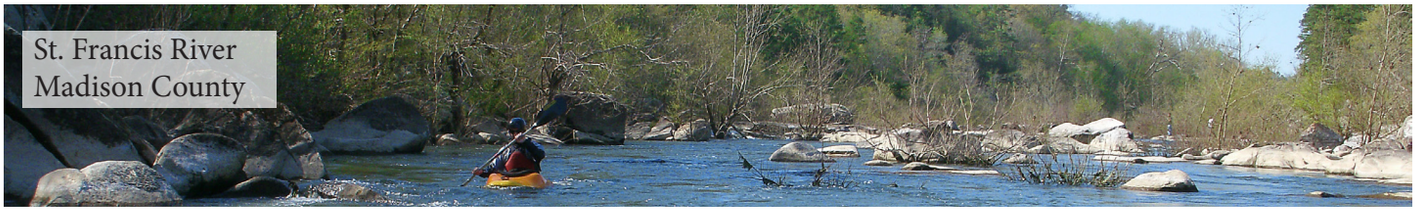
Regional Average = 21


ST 5268, Hubble Creek, Cape Girardeau County

Statewide Daily Dissolved Oxygen Variability

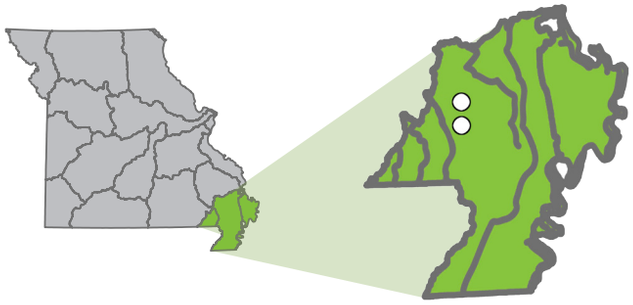
Here we show individual statewide dissolved oxygen concentrations (grey symbols, vertical axis) relative to time of measurement (horizontal axis). The blue circle shows the average value for each hour. While there were a wide range of values for every hour, samples from early and late in the day had lower readings than mid-day. Average values indicate a slight elevation in dissolved oxygen values during the afternoon.




St. Francis River
Madison County

Region 13 - St. Francis & Little Rivers

Mississippi Alluvial Basin Ecoregion



Region 13 is the only part of Missouri within the Mississippi Alluvial Basin Ecoregion and contains the Little River and the lower portions of the Black and St. Francis Rivers. This region is absolutely dominated by agriculture. More importantly, it is an area where natural flowing streams are a rarity, as most waterways have been channelized into a ditch network to aid in the movement of water off of the flat landscape. This is the least monitored region in the state.

Only two sites in Region 13 were sampled sufficiently for analysis in this report. The average chemistry values at those two sites do not indicate any water quality concerns, with no exceedances of the screening criteria. Invertebrate data, however, put the single assessed site near the bottom of the statewide ranking with a score of 17.

The extremely scant number of assessed sites may not adequately represent the regional water quality.

ST 1845, North Cut Ditch, Scott County

Region 13 Summary	Dissolved Oxygen (mg/L)	pH	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Chloride (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)
All Regional Measurements	26	27	26	15	20	5	25	25
Assessed Sites	2	2	2	1	2	0	2	2
Median (Assessed Sites)	9.0	8.2	0.42	0.49	0.48		372	17.5
Average (Assessed Sites)	9.7	8.0	1.03	0.45	0.70	161*	551	23.5

* There were no sites with sufficient chloride data for assessment; the average chloride value shown is for the 5 total chloride samples collected.

How VWQM Data Gets Used

First and foremost, VWQM data are used by the volunteer monitors themselves to gain a better understanding of stream conditions in the watershed in which they live, work, and play. Volunteers use their data to inform and educate others, and to advocate for state water resources. The VWQM dataset also provides valuable baseline information on our state's extensive stream network. We need baseline data to help us understand what is "normal." We need "before" and "after" data so we know how much good we have done for our streams, or in the worst cases, how much damage has been done.

With nearly 110,000 miles of streams in Missouri, Stream Team volunteers can help keep eyes on streams that our state agencies may not have the resources to monitor. Much like a neighborhood watch group alerts authorities to potential crime, Stream Team citizen scientists keep an eye out for the streams of Missouri. When used in this capacity, Stream Team data can help to direct state agencies to do follow-up monitoring where potential problems have been detected.

In addition to identifying waters for follow-up monitoring, Stream Team data have also been used in Watershed Management Plans, to track implementation of Total Maximum Daily Load plans (required of all "impaired" waters), and to initiate Cooperative Stream Investigations (CSI) projects. Stream Team data have also been used by the Missouri Department of Natural Resources to help develop monitoring strategies, by the U.S. Army Corps of Engineers and Missouri Department of Transportation in preparation of environmental impact statements, and by Kansas City in a program to reduce sewer overflows.

Action Requires Information

All efforts to protect and restore streams need data. We need baseline data so that, in the event of impairment, we know what the water quality goal should be for recovery. We need high quality data to help us identify potentially impaired waters. This information is essential for guiding our efforts to maintain and restore stream health. The well-trained citizen scientists of Missouri Stream Team VWQM are here to help with that effort.

ST 2504, Clear Creek, Boone County

Cooperative Stream Investigations - CSI

Stream monitoring serves several purposes. One is to provide baseline data on stream health. The baseline data will help us know what is "normal". If something goes wrong or conditions improve dramatically, we can compare the new data with the baseline data.

Another purpose of monitoring is to track long-term trends in water quality. Water quality will naturally vary from one year to the next depending on the climate and other factors. Except in cases of a catastrophic pollution event, discerning actual changes in water quality requires many years' worth of data.

These types of monitoring are sometimes called proactive monitoring. This is the type of monitoring that most Stream Teams are engaged in.

One other purpose served by monitoring is to solve problems. If there is a fish kill, for example, agency personnel will collect water samples from the area in an effort to determine the severity and source of the problem. This type of monitoring is triggered by an event or previous data results and is often called reactive monitoring. Stream Team data can be used as screening data to initiate reactive monitoring.

Cooperative Stream Investigation (CSI) is a program that involves volunteers in this process. CSI projects involve monitoring plans with specific purpose and additional scientific rigor. Volunteer CSI participants must be at least Level 2 VWQM monitors with current validation, and must commit to consistent, regular stream monitoring. CSI projects are designed to address a known water quality issue where monitoring data of a known and demonstrable quality is needed. Project volunteers receive training from Stream Team VWQM DNR staff on data collection using EPA-approved methods and equipment. This program may test for pollutants not normally measured by Stream Teams. While the focus is primarily on *Escherichia coli* (*E. coli*) bacteria, previous CSI projects have also investigated high in-stream values of chloride, nitrate, ammonia, and more (see table, next page).

Former CSI Coordinator Randy Sarver examines Creve Coeur Creek in St. Louis County at flood stage.

ST 463, Dardenne Creek, St. Charles County

Advanced Monitoring Projects (AMPs) provide additional opportunities for Level 2 monitors to contribute useful and necessary data, but do not require the stringent training and monitoring consistency of CSI projects.

For information about CSI or AMP, email: Streamteam@dnr.mo.gov.

Two CSI Projects

There have been several CSI projects since the program's creation in 2009. Here is a summary of just two of them.

Gravois Creek CSI Project, St. Louis County

Gravois Creek, a tributary to the River des Peres, was placed on Missouri's 303(d) list of impaired waters for having too much *E. coli*. To complete the required documentation (i.e. Total Maximum Daily Load, or TMDL), DNR needed more data. Stream Team 4220 teamed with DNR and a water quality laboratory to monitor chloride at eleven sites and *E. coli* at seven sites on Gravois Creek. In keeping with the strict quality control of the project, chain-of-custody forms were maintained that tracked all samples from the field to the lab.

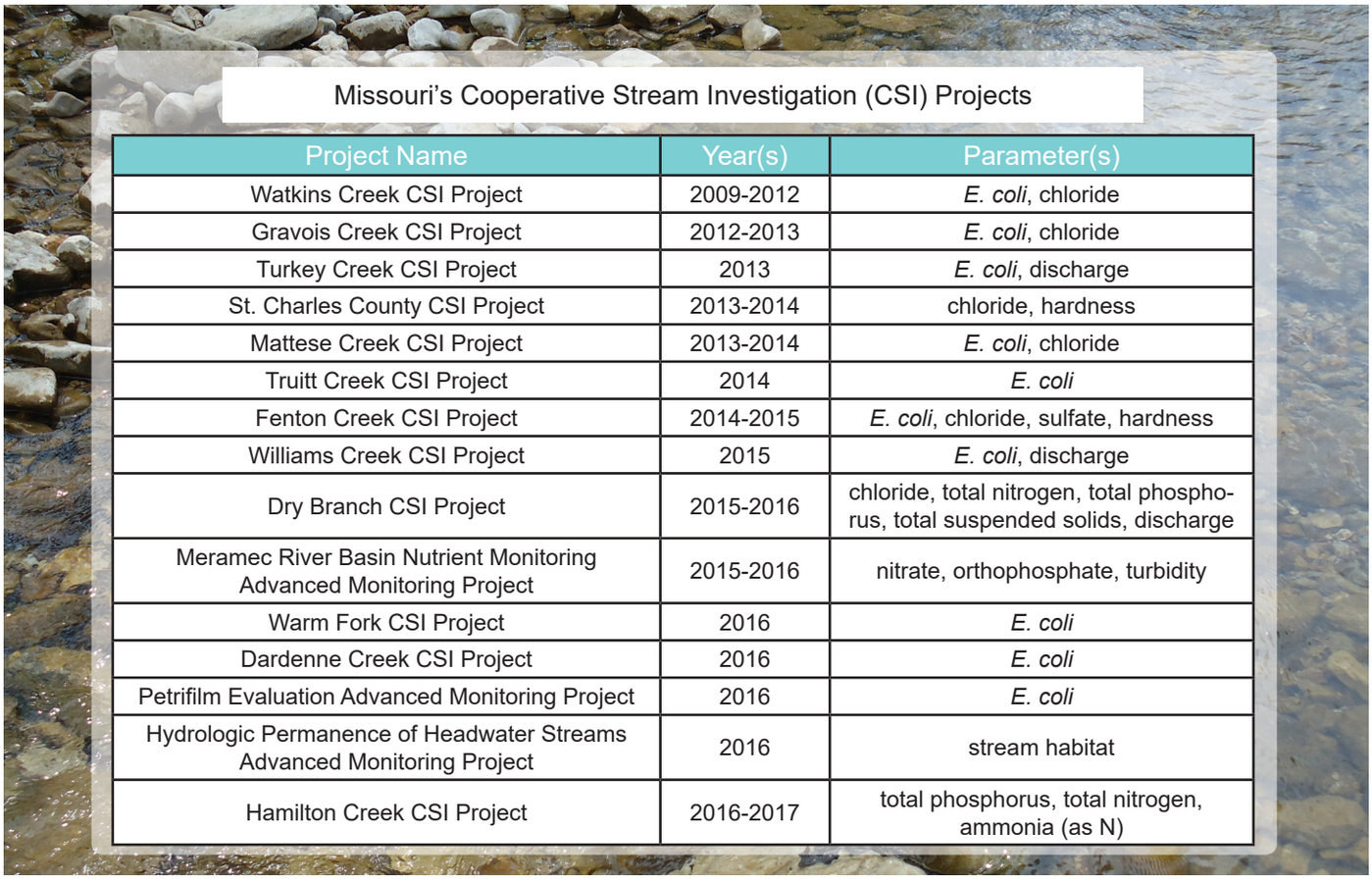
The volunteer measured chloride streamside with test strips provided by DNR, and quarterly chloride samples were analyzed in the lab according to EPA-approved methods. *E. coli* samples were collected by the volunteer and analyzed in the lab.

The project identified elevated chloride at all eleven locations during the winter season, and high *E. coli* at five of the seven monitored sites.

Williams Creek CSI Project, Lawrence County

Three stretches of Williams Creek and its major tributary, Truitt Creek, were designated as impaired in 2010 due to high *E. coli*. As a result, a TMDL had to be prepared by DNR and more data were required.

In 2015, CSI staff selected six sites and enlisted the help of Stream Team 4505 to collect water samples and perform the *E. coli* analyses. After six months of monitoring, results showed all sites except one exceeded *E. coli* Water Quality Standards criteria. The data also indicate that nonpoint source pollution was likely the source.



Missouri's Cooperative Stream Investigation (CSI) Projects

Project Name	Year(s)	Parameter(s)
Watkins Creek CSI Project	2009-2012	*E. coli*, chloride
Gravois Creek CSI Project	2012-2013	*E. coli*, chloride
Turkey Creek CSI Project	2013	*E. coli*, discharge
St. Charles County CSI Project	2013-2014	chloride, hardness
Mattese Creek CSI Project	2013-2014	*E. coli*, chloride
Truitt Creek CSI Project	2014	*E. coli*
Fenton Creek CSI Project	2014-2015	*E. coli*, chloride, sulfate, hardness
Williams Creek CSI Project	2015	*E. coli*, discharge
Dry Branch CSI Project	2015-2016	chloride, total nitrogen, total phosphorus, total suspended solids, discharge
Meramec River Basin Nutrient Monitoring Advanced Monitoring Project	2015-2016	nitrate, orthophosphate, turbidity
Warm Fork CSI Project	2016	*E. coli*
Dardenne Creek CSI Project	2016	*E. coli*
Petrifilm Evaluation Advanced Monitoring Project	2016	*E. coli*
Hydrologic Permanence of Headwater Streams Advanced Monitoring Project	2016	stream habitat
Hamilton Creek CSI Project	2016-2017	total phosphorus, total nitrogen, ammonia (as N)

Missouri Stream Team Program

Stream Teams are an impassioned voice for the protection of streams that Missourians rely on for clean drinking water, quality fishing, and first-class recreational opportunities. Volunteers generously give their time to understand, protect, and speak for our treasured streams. Activities such as litter pickups, which can range from casual litter removal while enjoying the outdoors to massive organized flood debris cleanups, empower citizens and give them ownership over the stream resource.

The three goals of the Missouri Stream Team Program are:

1. Education. Citizens with a passion for our streams are always seeking a deeper understanding of natural processes and how our actions affect water resources. Learning about Missouri's almost 110,000 miles of streams is as easy as it is fun. The Stream Team Program provides training for volunteers in subjects such as groundwater, stream hydrology, and aquatic animal identification through the Stream Team Academy. The Stream Team website provides online resources for educating others. Sharing information helps others better understand our stream systems and the problems and opportunities they face.
2. Stewardship. Hands-on activities such as stream cleanups, storm drain stenciling, tree planting, invasive species removal, and habitat improvement can show immediate and measurable results with lasting effects on streams. There is something profoundly satisfying about sore muscles, muddy clothes, and piles of trash waiting to be hauled away. Many large-scale events happen on an annual basis, inviting anyone interested in helping out. Stream Team biologists can also help you plan a project or connect you with Team activities to help you "get your feet wet."
3. Advocacy. Well-informed citizens who speak up for the resource can affect positive change in watershed practices and policies. Those who have gained first-hand knowledge of problems, solutions, and needs are best equipped to speak out on behalf of Missouri's stream resources, and can bring additional voices to the cause. Writing a letter, contacting representatives, and attending meetings or legislative hearings are ways to get involved.

ST 4608, Missouri River, Jackson County

Missouri Stream Team is a national leader in volunteer stream stewardship efforts thanks to the creativity and determination of our members. New activities continue to emerge, and just about anything that helps our streams counts as a Stream Team activity. Planting a rain garden, building a rain barrel, or simply observing changes in your adopted stream benefits the resource. As Teams grow and work together in their watersheds, impaired streams have the potential to return to supporting ample aquatic life simply due to implementing best management practices that show results.

Strength in numbers! Since the Program began in 1989, through the end of 2016, Stream Teams have reported:

- 29,494 water quality monitoring trips
- 11,873 tons of trash removed from streams and the landscape
- 333,527 trees planted
- 18,845 storm drains stenciled with the message "No Dumping – Drains to Stream"
- 5,027 educational events held, totaling 85,193 attendees
- 10,023 letters written
- 2,743,085 hours dedicated to Missouri streams

There is no doubt that Stream Teams will continue to find new ways to care for their adopted streams and make positive changes in their communities. Stream Teams are proof that Missourians care about clean water and know their own actions can improve their quality of life, even if they have to get a little muddy along the way.

MISSOURI STREAM TEAM

ST 5141, Elk River, McDonald County

ST 3745, River des Peres Watershed Coalition, St. Louis County

ST 1008, Meramec River, St. Louis County

Stream Teams United

stream teams united

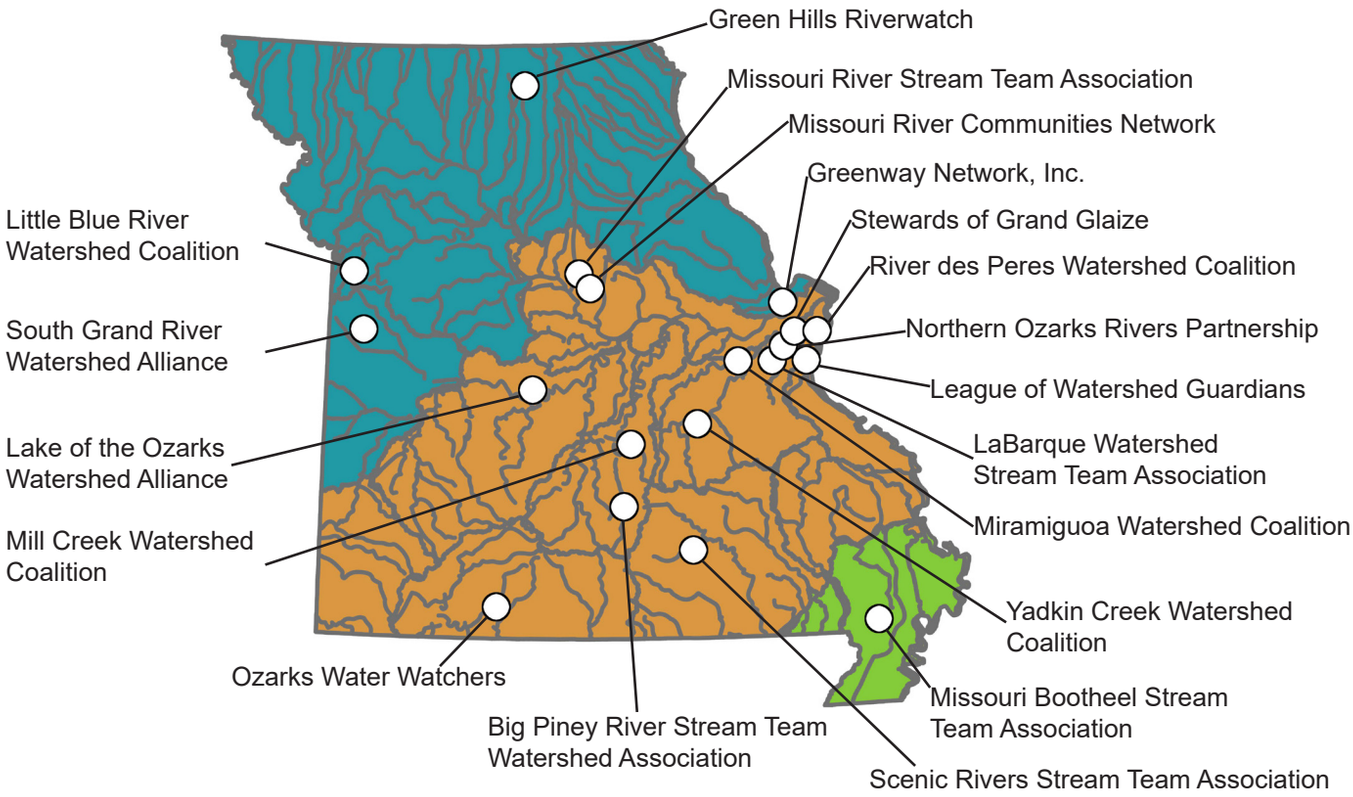
Linking Stream Teams for Healthy Watersheds

Stream Teams United (formerly Missouri Stream Team Watershed Coalition) is a nonprofit organization that supports the Missouri Stream Team Program and advances the protection and improvement of Missouri's waterways through education, advocacy, and stewardship. Stream Teams United is made up of representatives from Stream Team Associations throughout the state.

Stream Team Associations are groups of Stream Teams who work together on projects that affect their adopted streams. Forming an Association enables Stream Teams to:

- take on larger projects to make a greater impact,
- learn from other's experiences and challenges,
- share talents and resources, and
- enlist the support of other Stream Team Associations.

Our work includes developing educational watershed programs, encouraging citizen engagement by distributing alerts on issues affecting water resources, providing grants and scholarships to Stream Team volunteers, and publishing comprehensive State of the Streams reports that feature Stream Team Volunteer Water Quality Monitoring data.



For information on starting or joining a Stream Team Association, contact Stream Teams United at: teams@streamteamsunited.org

Additional Stream Teams United Projects

Did you know that in addition to being the Show Me State, Missouri is also the Great Rivers State? You can help spread the word by sporting your own personalized Great Rivers State license plate. In addition to sharing your love of Missouri's waters, you will be supporting Stream Teams United as we continue to actively protect the great rivers and streams of our state.

To order your personalized license plate, visit: http://mstwc.org/act-now/specialty-license-plates/

MISSOURI CLEAN MARINA

The Missouri Clean Marina program is a voluntary, incentive-based program that encourages marina operators and boaters to protect water quality by engaging in environmentally sound operating and maintenance. The goal of this program is to improve and protect the water quality of Missouri Lakes. The marina and boating industries depend on clean water for their continued success. Becoming a Missouri Clean Marina allows a marina to publicly demonstrate their stewardship of water quality.

Currently, all participating marinas are in southwest Missouri (Table Rock Lake and Lake Taneycomo). We are seeking new champions at lakes across the state!

For more information, visit: www.mocleanmarina.org

Paddle MO

Join us as we explore the last 100 miles of the Missouri River! In this unique journey on North America's longest river, you will be immersed in nature, visit historic river towns, and meet with experts along the way. Your Paddle MO registration includes 5 days on the river, camping with facilities, locally-sourced meals, gear transportation, entertainment, and more!

For more information, visit www.paddlemo.org

Members of the Stream Teams United board and Missouri Stream Team program staff in attendance at our 2017 fall meeting (l to r): Brooke Widmar, Karen Westin, Susan Wrasmann, Chris Riggert, Jenna Stiek, Steve Johnson, Sherry Fischer, Jeff Barrow, Danelle Haake, Larry Cain, Lily Kennedy, Diane Oerly, Larry Ruff, Amy Meier, Bill McIlwee, Melody Torrey, Besa Schweitzer, Alan Westcott, Cori Westcott, and Bob Coffing

Learn more about Missouri Stream Team, VWQM, and Water Quality topics:

For more information about Missouri Stream Team and the VWQM program:

- Contact Streamteam@DNR.mo.gov or Streamteam@MDC.mo.gov
- Or visit www.mostreamteam.org or www.dnr.mo.gov/env/wpp/VWQM.htm

To see VWQM monitoring site locations and view associated data, visit

- www.mostreamteam.org/mapwelcome.asp

To request VWQM data, please contact Streamteam@DNR.mo.gov

For more information about Missouri's Integrated Report (305b) and list of impaired waters (303d list), visit

- www.dnr.mo.gov/env/wpp/waterquality/303d/303d.htm

For more information about Total Maximum Daily Loads (TMDL) in Missouri, visit

- www.dnr.mo.gov/env/wpp/tmdl/

For more information about Watershed Management Plans, visit

- www.dnr.mo.gov/env/swcp/nps/watershedbasedplanning.htm

For more information about Stream Teams United, visit

- www.streamteamsunited.org

MISSOURI STREAM TEAM

ST 31, Current River, Shannon County